final report

Project Code: PRENV.021

Prepared by: Perrens Consultants

Date published: September 2003

ISBN 1 74036 530 5

PUBLISHED BY
Meat and Livestock Australia Limited
Locked Bag 991
NORTH SYDNEY NSW 2059

Stormwater management for the meat processing industry

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government and contributions from the Australian Meat Processor Corporation to support the research and development detailed in this publication.

CONTENTS

Page No

LIST OF TABLES

LIST OF FIGURES

SUMMARY

Background

Stormwater management is recognised by the meat processing industry as an area that is likely to be the subject of increasing regulation by government authorities. Combined with the benefits of improving the public perception of the industry, this has produced the need for a national stormwater management guideline for meat processing works. This report provides:

- An overview of current state of stormwater legislation in Australia that is relevant to meat processing works;
- An assessment of the water quality characteristics of stormwater from the various locations that are typical of meat processing works;
- Guidelines and concept designs for stormwater treatment systems that are applicable to the meat processing industry;
- Guidelines for the preparation of a site specific Stormwater Management Plan.

Although stormwater management at meat processing works is dealt with under a wide variety of regulatory mechanisms in the various States and Territories, it is clear that the environmental protection authorities are increasingly focussing on the control of stormwater runoff from industrial sites, including abattoirs. A number of common principles and strategies towards stormwater management are apparent from the various regulations, policies and guidelines namely:

Stormwater Management Strategies

- Diverting 'clean' runoff (eg from up-slope areas and roofs) away from areas of possible contamination
- Separating runoff from areas with different pollution generation characteristics
- Isolating (by bunding or roofing) areas of high pollution potential such as hide salting operations, solid waste dumps (eg paunch material) and fuel/chemical stores
- Providing separate stormwater collection, treatment and disposal systems that are appropriate for the nature of each of the pollutants concerned.

Stormwater Pollutant Characteristics

Any consideration of the potential for stormwater pollution to harm the natural environment must take account of its physical, chemical and biological effects. These characteristics, in addition to the mode of transport in water, govern what can be done to capture and treat polluted stormwater runoff. As a basis for understanding transport characteristics and treatment options, it is useful to distinguish three broad classes of pollutants and the associated treatment methods:

- **Gross pollutants** (eg litter, organic debris, coarse sediment) which are primarily transported as floating or entrained particles. These pollutants can be removed by simple primary treatment using a screen or filter. In general, gross pollutants are low risk pollutants which modify physical conditions and create adverse conditions for some organisms, but only cause short duration changes.

- **Floating or suspended matter** (eg oil and fine sediments). These pollutants require secondary treatment methods such as sedimentation or skimming floatable materials (oils etc) from the surface. By altering turbidity fine sediments provide a moderate risk of environmental harm. Oils, on the other hand, can seriously affect oxygen exchange between water and the environment and pose a high risk of detrimentally effecting aquatic organisms leading to long-term alteration of the ecosystem.

- **Dissolved materials** (including plant nutrients, heavy metals, pathogens and organic pollutants). These materials can only be removed using tertiary treatment processes such as chemical treatment or biological processes, such as bio-retention/filtration or wetlands. By altering water chemistry, most dissolved materials pose a moderate risk of detrimentally effecting aquatic organisms as a result of altering biophysical and physical conditions. Receiving ecosystems are only moderately resilient to such changes, and short duration changes to the ecosystem may result. Some 'dissolved' pollutants such as pesticides, heavy metals, salts, hydrocarbons and other carcinogens are directly toxic to aquatic organisms in low concentrations, difficult to break down into safer compounds or may be persistent in the environment and bio-accumulate in organisms. Ecosystems are not resilient to such pollutants.

Table S-1 summarises the sources of stormwater pollutants from different locations that are typical of meat processing works.

Table S-1
Pollutant Sources at Abattoirs

Operational Area	Litter	Vegetative Matter	Coarse Sediment	Fine Sediment	Oil and Grease	Nitrogen	Phosphorus	Organic Pollutants	Metals	Pathogens	Chemicals	Salts
Animal Handling Facilities												
Stock holding paddocks	-	✓	✓	✓	-	-	-	✓	-	✓	-	-
Stock holding yards	-	-	✓✓	✓	-	✓✓	✓✓	✓✓	-	✓	-	✓
Stock holding pens	-	-	-	-	-	✓✓	✓✓	✓✓	-	-	-	✓
Pre-processing race	-	-	-	-	-	✓✓	✓✓	✓✓	-	-	-	-
Yard and Ancillary Processing Areas												
Truck washdown area	-	-	✓	-	✓✓	-	-	✓✓	-	✓✓	✓	-
Product loading dock	✓	-	-	-	-	-	-	-	-	-	-	-
Tallow loading area	-	-	-	-	✓	-	-	-	-	-	-	-
Hide salting and drying sheds	-	-	-	-		-	-	-	-	-	-	✓✓
Open yard areas	✓✓	-	-	-		-	-	-	✓	✓	-	-
Workshops	-	-	-	-	✓✓	-	-	-	-	-	-	-
Roads and car parks	-	-	-	-	✓	-	-	-	✓	-	-	-
Waste Storage and Disposal												
Solid waste storage and composting	-	-	-	-		-	✓	✓✓	-	✓✓	-	-
Solid waste disposal	-	-	-	-		-	✓✓	✓✓	-	✓✓	-	-
Effluent irrigation area			✓	✓✓		✓✓	✓	-	✓	✓	-	-
Fuel and Chemical Storage												
Fuel storage	-	-	-	-	✓✓	-	-	-	-	-	-	-
Re-fuelling facilities	-	-	-	-	✓✓	-	-	-	-	-	-	-
Chemical storage	-	-	-	-		-	-	-	-	-	✓✓	-
Salt storage	-	-	-	-	✓	-	-	-	-	-	-	✓✓

Key: ✓ minor issue ✓✓ significant issue

Stormwater Management Principles

The fundamental principles of stormwater management are exactly the same as those applied to the management of effluent streams, namely:

- **Avoidance** by preventing contact of stormwater with pollutant sources (eg a roof to prevent rainfall coming in contact with the pollutant source).
- **'At source'** separation of stormwater into at least three streams:
  - 'clean' runoff from surfaces such as roofs,
  - 'Dirty' runoff that is degraded through contact with soil, oils, etc,
  - 'Contaminated' runoff that has been in contact with manure or processing wastes.
- **Re-use** of stormwater for compatible purposes (eg roof runoff for truck washdown).
- **'Treatment train'** approach involving a series of treatment steps (primary, secondary, tertiary)

An element of the strategy of stormwater separation may be to separate the 'first flush' of runoff containing a higher level of pollutants than later runoff. This strategy is only valid, however, in situations in which there is a finite quantity of pollutant available for transport (eg dust deposited on a yard), the pollutant is immediately available for transport (it does not require dissolving before transport) and the transport capacity of the flow is not a limiting factor. Provided these conditions are met, capturing the 'first flush' is likely to be a successful pollution control strategy which permits the subsequent treatment and disposal of a limited volume of stormwater that contains the majority of pollutants. It is common practice in many situations to adopt a 'first flush' capture of 10-20 mm of runoff, although there is little theoretical justification for this.

Stormwater Treatment Techniques

The types of stormwater treatment that are most appropriate to the meat processing industry are those that have low capital costs, are capable of treating a range of pollutants and are easily retro-fitted into an existing stormwater drainage system. Many commercially available stormwater treatment devices do not satisfy all of these attributes. Table S-2 summarises the applicability of a variety of stormwater treatment techniques suitable for meat processing works. Design guidelines for each of these treatment systems and devices are outlined in this report.

Table S-2
Stormwater Treatment Selection Criteria

Pollutant	Grated Pit / Screens	Grass Swale	Filter Strip	Oil Separator	Sediment Basin	Wetland	Evaporation Pond	Bio-retention Swale/Basin
Litter	✓	P	P	P	P	P	P	P
Pellet manure	✓	X	P	P	✓	P	P	P
Coarse Sediment	X	✓	✓	✓	✓	P	P	✓
Fine Sands	X	✓	✓	✓	✓	P	P	✓
Clays	X	X	0	X	0	0	P	0
Total Nitrogen	X	0	✓	X	0	✓	X	✓
Total Phosphorous	X	0	✓	X	✓	✓	X	✓
Dissolved Phosphorous	X	X	✓	X	X	✓	X	✓
Oils and Hydrocarbons	X	X	X	✓	X	0	X	0
Grease	X	P	P	✓	P	P	X	P
Salts	X	X	X	X	X	X	✓	X
Chemicals	X	P	0	X	X	X	X	X

LEGEND

Inappropriate Technique	X	Partially Treatable	0
Appropriate Technique	✓	Pre-treatment Required	P

Preparation of Stormwater Management Plans

The preparation of a Stormwater Management Plan (SMP) provides a risk management framework where risks to stormwater quality are identified, ranked and suitable mitigation options presented. A stormwater management plan is often required for sites that are located near environmentally significant areas or major waterways. The primary objective of a SMP is to identify sources of stormwater degradation and actions by which the environmental values of receiving waters will be protected. While a SMP is usually produced to satisfy the requirements of an environmental protection licence it is also a useful tool for aiding in the efficient environmental management of a site, and in some circumstances may form part of an environmental management plan (EMP) for the whole facility.

The matters that should be included in a SMP are:

- A description of the existing stormwater management system;
- Identification of pollutant sources;
- A description of the processing by which stormwater separation and collection occurs;
- Design principles for treatment techniques;
- Priority listing of actions to protect receiving waters;
- Timetable for works and actions necessary to implement the plan.

1.0 INTRODUCTION

Stormwater management is recognised by the meat processing industry as an area that is likely to be the subject of increasing regulation by government authorities. Combined with the benefits of improving the public perception of the industry, this has produced the need for a national stormwater management guideline for meat processing works.

While there is wealth of information available on stormwater management 'best practices' for urban residential and industrial areas, the characteristics of stormwater generated by these areas differ significantly from stormwater generated from meat processing sites. The stormwater characteristics of meat processing works have more in common with those of intensive livestock areas such as feedlots. At such sites, pollutant generation from areas such as stock holding pens and waste stockpiles generally remain fairly constant throughout the duration of a storm. The implication of this is that typical 'first flush' treatment technologies such as those used in many urban industrial stormwater situations may be relatively ineffective for such areas.

This report outlines a range of appropriate strategies and stormwater treatment techniques that are suitable for meat processing works.

1.1 OBJECTIVES

The specific aims of this report are:

- To review current Australian standards, guidelines and regulations in terms of current requirements for stormwater runoff control and treatment, both generally and for the meat processing industry specifically;
- To review current technology, practices and strategies for minimising pollutant loads and treating stormwater at meat processing sites;
- Provide recommendations for the meat industry to design an integrated industry specific approach to stormwater management.

Implementation of the recommendations of this study will benefit the meat processing industry in a number of ways, including:

- Enhanced environmental protection resulting from appropriate stormwater management systems.
- Industry specific guidelines that address the particular stormwater pollution problems using technologies that are appropriate to the industry.
- Guidelines that can be used as a basis for negotiation with the regulatory agencies in developing site specific pollution control plans.
- Stormwater capture and treatment technologies that are integrated, as appropriate, with other water treatment processes on the site.
- Cost effective treatment technologies that take full account of the ongoing maintenance requirements for stormwater treatment.
- Information that can be used to help give the community an improved understanding of the stormwater runoff characteristics resulting from meat processing facilities.

Chapters 2 and 3 of this report provide an overview of stormwater management issues including an introduction to the characteristics and sources of stormwater pollutants and a review of stormwater issues at abattoirs. Chapters 4 and 5 set out the general principles and guidelines for stormwater management and specific guidelines for stormwater management on operational areas of abattoirs while Chapters 6 and 7 describe the design principles for stormwater collection and separation devices. Finally, Chapter 8 sets out the requirements for the preparation of stormwater management plans.

1.2 CURRENT LEGISLATION

The legislative environment for stormwater management at meat processing sites varies considerably between the various States and Territories. Stormwater controls for abattoirs are predominantly in the form of policies and industry guidelines, with control most often being regulated by environmental protection licences. The relevant policies and guidelines for each of the State and Territories are outlined in Appendix A.

Many of the guidelines fail to distinguish between the terms 'contaminated' and 'dirty' stormwater when referring to stormwater segregation. Both these types of stormwater have different management and treatment implications. In addition, the guidelines sometimes conflict over whether stormwater should be directed to the abattoir's effluent treatment system.

Overall, many of the policies are principally focussed on management of the abattoir’s effluent treatment system rather than stormwater management. The various industry guidelines are similarly focussed, although some specifically mention stormwater separation strategies. Table 2.1 provides a summary of which States and Territories specifically mention stormwater management at meat processing works.

Although stormwater management at meat processing works is dealt with under a wide variety of regulatory mechanisms in the various States and Territories, it is clear that the environmental protection authorities are increasingly focussing on the control of stormwater runoff from industrial sites, including abattoirs. A number of common principles and strategies towards stormwater management are apparent from the various regulations, policies and guidelines:

- Diverting ‘clean’ runoff (eg from up-slope areas and roofs) away from areas of possible contamination;
- Separating runoff from areas with different pollution generation characteristics;
- Isolating (by bunding or roofing) area of high pollution potential such as hide salting operations, solid waste dumps (eg paunch material) and fuel/chemical stores;
- Providing collection, treatment and disposal systems that are appropriate for the nature of the pollutants concerned.

Table 1.1
Summary of Approaches to Stormwater Management at Meat Processing Works

State/ Territory	Specific Mention of Stormwater Management at Abattoirs			
	Regulations	Policies	Guidelines / Code of Practice	General Publications
ACT		✓		
NSW			✓	✓
NT				✓
QLD				✓
SA			✓	
TAS			✓	
VIC		✓		✓
WA	✓		✓	✓

2.0 STORMWATER POLLUTANTS

In order to understand how to manage stormwater it is important to know where pollutants are generated and what form they take so that appropriate treatments can be used to target such pollutants. The following sections describe:

- The important characteristics of stormwater pollutants;
- The main processes of stormwater pollutant generation;
- The threats that various pollutants pose to the natural environment.

2.1 STORMWATER POLLUTANT CHARACTERISTICS

Any consideration of the potential for stormwater pollution to harm the natural environment must take account of its physical, chemical and biological effects. These characteristics, in addition to the mode of transport in water, govern what can be done to capture and treat the different types of pollutants. As a basis for understanding transport characteristics and treatment options, it is useful to distinguish three broad classes of pollutants and the associated treatment methods that are outlined in further detail in subsequent sections:

- **Gross pollutants** (eg litter, organic debris, coarse sediment) which are primarily transported as floating or entrained particles. These pollutants can be removed by simple primary treatment using a screen or filter.
- **Floating or suspended matter** (eg oil and fine sediments). These pollutants require secondary treatment methods such as sedimentation or skimming floatable materials (oils etc) from the surface.
- **Dissolved materials** (including plant nutrients, heavy metals, pathogens and organic pollutants). These materials can only be removed using tertiary treatment processes such as chemical treatment or biological processes, such as bio-retention filters or wetlands.

2.1.1 Gross Pollutants

Gross pollutants encompass all items larger than sand sized particles (>2 mm) and include:

- **Litter** (eg paper, plastic, bottles and cans) that not only smother vegetation, but may also degrade slowly. At an abattoir, this class would include meat and hide scraps dropped in the course of transport between sections of the plant;
- **Vegetative matter** (eg seeds, natural leaf fall or grass clippings from mowing) which, when transported by storm runoff, can be moved long distances from the point of origin. Seeds of exotic weed species are often a significant environmental threat to sensitive natural areas such as bushland, natural wetlands and creeks;
- **Coarse sediments**

Gross pollutants can accumulate from traffic movements or litter and debris dropped around a site. In general, the total mass accumulated will be a function of time since the last runoff event. Because they are transported by floating with the flow (ie. they have a specific gravity less than one), they will tend to arrive at an outlet point with the ‘first flush’ of flow. This first flush effect is particularly noticeable on small catchments where the time of concentration is only a few minutes.

Gross pollutants are generally the easier to control than other classes of pollutants and can usually be removed by primary treatment methods such as filtration using a screen or coarse filter. They are also the least damaging pollutants to aquatic ecosystems. However, additional benefits may occur when gross pollutants are removed as other more damaging pollutants are often captured as a result of interception by the gross pollutants or through sedimentation behind screen devices.

2.1.2 Floating and Suspended Matter

This group of materials is distinguished by the fact that they do not readily dissolve in the water. Although some of the materials float in the same way as gross pollutants (eg oil and fuel), they have been classified separately because they are more difficult to remove from stormwater runoff. Examples of this group include:

- **Fine sediments** which tend to get deposited in areas of low velocity flow and consequently cause a reduction in flow area and even bury the vegetation. This class includes dust originating from the atmosphere, vehicle exhaust, metal wear and brake linings. The 'heavy' metals such as lead, zinc and copper are of particular concern because of their toxic effects on animal life and their persistence in the environment Fine sediments are typically more damaging to the environment than coarser sediment because they carry adsorbed nutrients and metals. Phosphorus in particular is strongly adsorbed onto clay particles and is usually transported in this way.
- **Hydrocarbons** which, depending on their viscosity and volatility, can form a film on the surface of any standing water and inhibit oxygen exchange which may eventually kill any aquatic insects, fish and fauna. Some hydrocarbons are also carcinogenic. This class may include oils, grease and other hydrocarbons originating from vehicles or from the road surface itself as well as spilt tallow. Oils show a tendency to be transported by the first flush of runoff.

This group of materials usually require physical removal by settling particles out of the flow, or skimming floatable materials (oils, etc) from the surface. They are more difficult to remove than gross pollutants. Data from road runoff in Sydney (Batley et al 1994) indicates that much of the dust containing heavy metals has particles the size of silt or clay. These particles may take weeks or months to settle out of suspension naturally.

2.1.3 Dissolved Materials

This group includes:

- **Plant nutrients** (nitrogen and phosphorus) which can encourage plant growth to the extent that native vegetation (which is adapted to low nutrient levels) becomes overtaken with exotic weed species. Nutrient rich water is also the cause of algal blooms that occur in rivers and estuaries around Australia. Nitrogen and phosphorus in stormwater originate from decaying organic debris, food products, animal excreta and fertilisers. As noted above, phosphorus tends to be strongly adsorbed onto clays and transported with them.
- **Organic pollution** (for example animal faeces) which provide a food source for bacteria and create biological oxygen demand (BOD). Bacteria, in the course of breaking down these materials, also consume oxygen from the water which can make it unfit for other forms of life which normally live in the water. This depletes oxygen levels in downstream waterways causing odours and loss of aquatic life.
- **Metals**, some of which are highly toxic to aquatic organisms and are also relatively persistent once they enter the environment. US data indicates that many of the metals transported in runoff are in the dissolved form.
- **Pathogens** from animal excreta and food scraps. Although bacteria are more correctly classed as 'particles' their mode of transport within the runoff makes them behave more like dissolved materials in terms of the processes necessary to remove them.

- **Chemicals** such as detergents, pesticides and herbicides used for maintenance purposes around meat processing works. A particular issue at many abattoir sites is the salting of hides and the potential for salt to enter the stormwater system.

Because a number of these pollutants need to be dissolved before they can be transported, they tend to be less affected by the 'first flush' of runoff than sediments and gross pollutants. This class of pollutants is difficult to remove from runoff and because of their dissolved nature. They are often the most harmful pollutants to the environment as they are readily absorbed aquatic ecosystems. The only practical options for treatment of dissolved pollutants is to use tertiary treatment methods such as the biological and absorptive capacity of bio-retention filters, artificial wetlands, wet detention basins or buffer strips. Chemical treatment may also be used to remove phosphorous through precipitation, or to cause flocculation of dispersive clays and the attached phosphorous and other pollutants such as metals.

2.2 STORMWATER POLLUTANT TRANSPORT PROCESSES

The physical and chemical characteristics of pollutants dictate the mechanism by which transport occurs and, in turn, provide a basis for developing appropriate treatment methods.

2.2.1 First Flush

'First flush' is a term that refers to the initial washoff of pollutants from a surface during a storm, often resulting in greater concentrations of pollutants. Situations in which a 'first flush' effect have been clearly demonstrated are those in which the pollutants are deposited on the surface, not generated from the surface itself, and the pollutant is easily transported. Examples of this are:

- washoff of deposited fine dust from a roof;
- washoff of dust and oil from a sealed road surface;
- washoff of dust and dirt from a sealed car park.

In all these cases, the phenomenon of 'first flush' has been clearly demonstrated in the technical literature because of three factors:

- a finite quantity of pollutant is available for transport;
- the pollutant is immediately available for transport (it does not require dissolving before transport);
- the transport capacity of the flow is not a limiting factor.

Provided these conditions are met, capturing the 'first flush' is likely to be a successful pollution control strategy which permits the subsequent treatment and disposal of a limited volume of stormwater that contains the majority of pollutants. It is common practice in many situations to adopt a 'first flush' capture of 10-20 mm of runoff, although there is little theoretical justification for this.

Goal of First Flush Collection – Retain the most polluted stormwater and restore first flush volume as soon as possible by appropriate treatment of the retained 'first flush'.

A variation of the 'first flush' principle has been adopted for construction sites in NSW which have fine or dispersible soils. In that case, the recommended strategy is to collect all runoff from a five day rainfall event with a nominated probability of occurrence. (The five day timeframe was established to allow a margin of safety for a storm event commencing just prior to a weekend and continuing throughout the weekend when the construction site was unattended.) The probability of occurrence to be adopted in any particular situation is dependent on a number of factors including the level of environmental protection required, with the 90^{th} percentile probability being generally the highest level of environmental protection applied.

There is still considerable debate amongst hydrologists and water quality scientists about the occurrence of any ‘first flush’ effect in any complex catchment that contains a mixture of surfaces such as roads, roofs and natural surfaces, such as grass or gardens. In such situations any ‘first flush’ effect is likely to be hidden by the mixing processes of runoff from the different surfaces.

Table 2.1 shows the areas of an abattoir for which first flush capture is appropriate.

Table 2.1
Abattoir Operational Areas Where First Flush Capture is Considered Appropriate

Operational Area	First Flush Capture
Roof Areas	✓
Animal Handling Facilities	-
Stock holding paddocks	-
Stock holding yards	-
Stock holding pens	-
Yard and Ancillary Processing Areas	
Truck washdown area	✓
Product loading dock	✓
Tallow loading area	✓
Hide salting and drying sheds	-
Open yard areas	-
Workshops	✓
Roads and car parks	✓
Waste Storage and Disposal	
Solid waste storage and composting	-
Solid waste disposal	-
Effluent irrigation area	-
Fuel and Chemical Storage	
Fuel storage	-
Re-fuelling facilities	-
Chemical storage	-
Salt storage	-

2.2.2 Rate Limited Processes

For many pollutants, the pollutant concentration in runoff is a function of the capacity of the flow to transport the pollutant, not the quantity of pollutant available. A simple example of this is erosion of soil from a cultivated paddock where the mass of soil available for transport is much greater than could be removed in a single storm. In this situation, the quantity of sediment actually transported from the surface during a storm is a function of the ‘erosivity’ of rainfall to detach particles from the soil mass and the flow velocity to transport the particles.

Many of the pollutant sources within a meat processing facility such as holding yards and paddocks, solid waste disposal areas and effluent irrigation areas have pollution generating characteristics that are governed by rate limited processes.

2.3 POLLUTANT RISK TO THE ENVIRONMENT

The risk that each type of stormwater pollutant poses to its receiving environment is highly dependant on:

- the resilience of the receiving environment and its existing state of degradation,
- the concentration of the pollutant; and
- the frequency at which the pollutant it is discharged into the environment.

A generalised rating of pollutant risk may be based on the following three categories of pollutant risk which consider effects at both the organism and ecosystem level.

- **High risk pollutants**
  Those pollutants that are directly toxic to aquatic organisms in low concentrations, difficult to break down into safer compounds or may be persistent in the environment, bio-accumulating in organisms. Ecosystems are not resilient to such pollutants and long-term alteration of the ecosystem may result. High risk pollutants include pesticides, heavy metals, salts, hydrocarbons and other carcinogens.

- **Moderate risk pollutants**
  Those pollutants that detrimentally effect aquatic organisms indirectly by altering water chemistry and may alter biophysical and physical conditions of an ecosystem. The receiving ecosystem is only moderately resilient to such changes, and short duration changes to the ecosystem may result. Moderate risk pollutants may include nutrients such as phosphorous and nitrogen, salts, deoxygenating materials and fine sediment.

- **Low risk pollutants**
  Those pollutants which may modify physical conditions of the water to create adverse conditions for some organisms. However, changes in the environment are generally of short duration, with aquatic ecosystems showing a high resilience to these changes. Such pollutants may include coarse sediment, deoxygenating materials and litter.

Exact classification of pollutants into one of the three risk categories is not possible as some pollutants have varying risk, depending on the pollutant concentration and the characteristics of the receiving environment. For example, a low concentration of salts may only constitute a moderate risk compared to highly saline brine that is a high risk pollutant.

3.0 CURRENT STORMWATER MANAGEMENT PRACTICES

In order to ascertain the types of stormwater management issues faced by the meat processing industry, a questionnaire was distributed to abattoirs across Australia and follow-up inspections were conducted at nine selected sites in eastern Australia.

3.1 MEAT PROCESSING INDUSTRY STORMWATER QUESTIONNAIRE

The meat processing industry contains a wide variety of sizes and ages of enterprises, which is reflected in a wide variety of environmental performance. To gain insight as to the stormwater issues over these enterprises, approximately 60 questionnaires were issued to abattoirs in NSW, VIC, QLD, WA and SA. The objective of the questionnaire was to gain insight into how the abattoir industry is managing stormwater, and to determine what level of understanding the industry has about stormwater management issues on abattoirs.

The specific aims of the questionnaire were to assess the:

- extent to which abattoirs were implementing source separation of stormwater;
- types of stormwater treatment methods being used on abattoirs;
- types of areas where abattoirs are generating contaminated stormwater;
- degree of importance that is placed on stormwater management in abattoirs.

Of the questionnaires issued a 55% return rate was achieved, which is considered an excellent reply rate for a survey of this type.

3.2 INDUSTRY SITE INSPECTIONS

Following the return of the questionnaires, inspections of selected abattoirs in NSW, VIC and QLD were undertaken. The inspections were conducted in order to provide a benchmark of current industry practice and to identify the opportunities and constraints to better stormwater management practice. All site inspections were conducted on the basis of strict confidentiality.

A total of nine site inspections were undertaken, with the number of abattoirs inspected in each state as follows:

- New South Wales - 5
- Victoria - 2
- Queensland - 2

The following sections describe the types of pollutant sources identified from the questionnaire and site inspections and outline the current state of stormwater management at meat processing sites in Australia.

3.3 SOURCES OF STORMWATER POLLUTANTS

Based on the information obtained from both the questionnaire and the site inspections, the following areas within the abattoirs were identified as being potential sources of stormwater pollutants:

3.3.1 Animal Handling Facilities

- ***Stock holding paddocks***

  These areas are semi-intensively stocked, although not as intensively as a feedlot or stock saleyards. Pollutant generation from these areas is greatly dependant upon the condition of the vegetation on the paddock, the number of stock held on the paddock and the duration for which they are held. Runoff from these paddocks is largely uncontrolled.

- ***Stock holding yards***

  These areas are stocked as intensively as feedlots or stock saleyards. However, because stock is not kept in the stock holding yards for long periods of time, less manure and urine is produced compared to feedlots. In most instances these yards are roofed and solid wastes are removed by scraping. In situations where the holding yards are uncovered, drainage is directed to either the effluent treatment system or to the stormwater drainage system.

- ***Stock holding pens***

  These pens are usually undercover although stock may be sprayed for cleaning. Drainage from this area is directed to the effluent treatment ponds.

- ***Pre-processing race***

  This area is under cover, where stock is given a high pressure spray with potable water to clean off dirt and manure. Drainage from this area is directed to the effluent treatment ponds.

3.3.2 Yard and Ancillary Processing Areas

- ***Delivery truck washdown area***

  This area is a possible source of oils, sediment, manure pellets and detergent. Where there is a clearly defined area for this activity, drainage is directed into the effluent treatment system.

- ***Product loading dock***

  Product loading usually, but not always, occurs under a roofed area. Surface drainage from this area is usually directed to the stormwater drainage system and any spilt product could enter the stormwater system.

- ***Tallow loading area***

  Heated tallow is stored in vats in loading areas where tallow spills may occur. This activity frequently occurs in an unbunded open yard area where any spillage would enter the stormwater drainage system.

- ***Hide salting sheds***

  Salting of hides is undertaken within an enclosed shed. In many instances, however, floor drainage can escape onto outside yard areas and wet hides are transported across open yard areas. Brine draining to, or falling on, these open yard areas is transported by stormwater.

- ***Open yard areas between buildings***

  This area is frequently used for general vehicle movements to transport by-products and wastes (eg offal, skins, paunch material) to other sections of the plant. Spilt materials from open trucks and bins have the potential to enter the stormwater drainage system.

- ***Workshop area***

  At some workshops the forecourt area is used for parking vehicles and machinery in the course of repair and maintenance. These activities provide a potential source for oil and grease to enter the stormwater drainage system.

- ***Roads and car parks***

  In most situations, the car park runoff enters the stormwater drainage system without treatment.

3.3.3 Waste Storage and Disposal

- ***Solid waste storage and composting areas***

  These areas are used to store paunch material, DAF sludges and material for composting. In many situations runoff from this area is uncontrolled.

- ***Solid waste disposal area***

  Paunch wastes are often dry dumped in paddocks and may leach nutrients and contain weed seeds.

- ***Effluent irrigation area***

  Runoff from effluent irrigation areas may contain nutrients and sediment. However, these areas are unlikely to produce large runoff volumes as intensively managed pasture or cropping areas do not typically exhibit volumetric runoff coefficients greater than 10%.

3.3.4 Fuel and Chemical Storage

- ***Fuel storage***

  These areas represent a possible source of hydrocarbon contamination in the event of storage container failure. Normally fuel storage is located in a bunded and roofed enclosure.

- ***Refuelling facilities***

  A possible source of hydrocarbon contamination in the event of a spillage. The refuelling facility is often located in an unbunded open yard area where any spillage will enter the stormwater drainage system.

- ***Chemical storage***

  Chemicals for cleaning and tanning may contaminate stormwater if not stored correctly. Typically these are stored within the main plant area where they are protected from the weather and where any spillage will drain to the effluent treatment system.

- ***Salt storage***

  Used for salting of hides. Brine will be produced if salts are exposed to rainfall.

The areas identified above all produce different pollutants due to the varying types of activities being conducted in each of the areas. Table 3.1 summarises the types of stormwater pollutants that are associated with each of the areas, together with a rating of the significance of the issue. The significance of each of the pollutants likely to be produced off each operational area is an estimate derived from the site inspections, correspondence with abattoirs and an assessment of the activities occurring within each area.

Table 3.1
Significant Pollutant Sources at Abattoirs

Operational Area	Litter	Vegetative Matter	Coarse Sediment	Fine Sediment	Oil and Grease	Nitrogen	Phosphorus	Organic Pollutants	Metals	Pathogens	Chemicals	Salts
Roof Runoff	-	✓	-	✓	-	-	-	-	-	-	-	-
Animal Handling Facilities												
Stock holding paddocks	-	✓	✓	✓	-	-	-	✓	-	✓	-	-
Stock holding yards	-	-	✓✓	✓	-	✓✓	✓✓	✓✓	-	✓	-	✓
Stock holding pens	-	-	-	✓✓	-	✓✓	✓✓	✓✓	-	✓✓	-	✓
Pre-processing race	-	-	-	-	-	✓✓	✓✓	✓✓	-	-	-	-
Yard and Ancillary Processing Areas												
Truck washdown area	-	-	✓	-	✓✓	✓	✓	✓✓	-	✓✓	✓	-
Product loading dock	✓	-	-	-	✓	-	-	✓	-	-	-	-
Tallow loading area	-	-	-	-	✓	-	-	-	-	-	-	-
Hide salting and drying sheds	-	-	-	-	✓	✓✓	✓	✓✓	-	-	✓✓	✓✓
Open yard areas	✓✓	-	-	-		-	-	-	✓	✓	-	-
Workshops	-	-	-	-	✓✓	-	-	-	-	-	-	-
Roads and car parks	-	-	-	-	✓	-	-	-	✓	-	-	-
Waste Storage and Disposal												
Solid waste storage and composting	-	-	✓	✓✓	-	✓✓	✓	✓✓	-	✓✓	-	-
Solid waste disposal	-	-	-	-	-	-	✓✓	✓✓	-	✓✓	-	-
Effluent irrigation area	-	-	✓	✓✓	-	✓✓	✓	-	✓	✓	-	-
Fuel and Chemical Storage												
Fuel storage	-	-	-	-	✓✓	-	-	-	-	-	-	-
Re-fuelling facilities	-	-	-	-	✓✓	-	-	-	-	-	-	-
Chemical storage	-	-	-	-		-	-	-	-	-	✓✓	-
Salt storage	-	-	-	-	✓	-	-	-	-	-	-	✓✓

Key: ✓ minor issue ✓✓ significant issue

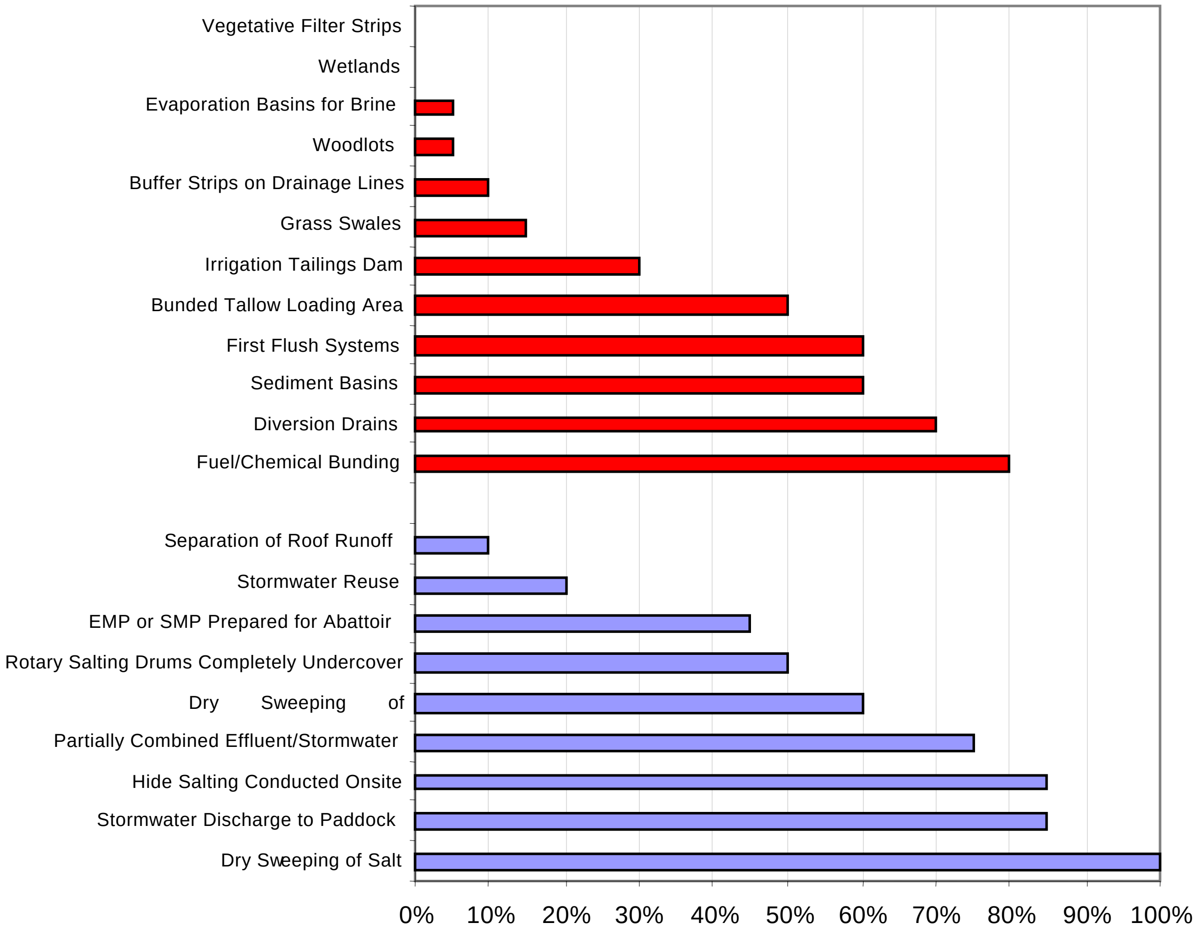
3.4 THE CURRENT STATE OF ABATTOIR STORMWATER MANAGEMENT

The findings of the questionnaire and site inspections indicate that the level of stormwater management undertaken on abattoirs is influenced by the following key factors:

- The degree to which stormwater management/treatment is provided by the effluent treatment system;
- The location of various operational areas within the catchment area, which could constrain the extent to which stormwater segregation or treatment could be undertaken;
- The availability of land to utilise stormwater treatment techniques;
- The nature of the existing infrastructure which may limit the use of certain stormwater treatment techniques.

Based on responses from the questionnaire and site inspections, Figure 3.1 summarises the frequency of use of various stormwater management technologies at meat processing sites.

Figure 3.1
Stormwater Management & Treatment Technologies Being Used at Meat Processing Sites



4.0 STORMWATER MANAGEMENT GUIDELINES

This section provides an overview of stormwater management principles, collection and separation strategies and a description of stormwater treatments that are applicable to meat processing sites. Following on from this introduction to stormwater management, specific stormwater management recommendations for abattoir operational areas are discussed in Chapter 5.

4.1 STORMWATER MANAGEMENT PRINCIPLES

Stormwater management is one element of the environmental performance of a site. A generalised hierarchy of stormwater management that would be applicable to abattoirs is shown in Figure 4.1. This figure shows that highest priority should be given to site design and management that avoids the contact of stormwater with potential pollutants (eg roofing areas of highest pollutant risk or diverting up-slope runoff around a paunch dump/composting area). The figure shows that second priority should be given to re-use of stormwater for appropriate purposes (eg re-use of 'dirty' runoff for irrigation of stock holding paddocks or landscaping). Treatment should follow the hierarchy shown with the least preferred option being disposal of stormwater to the receiving waters, particularly if the impacts of this disposal cannot be adequately managed through stormwater treatment. However, where the stormwater has been adequately treated and appropriate re-use options are not available, release of stormwater to the environment may be necessary.

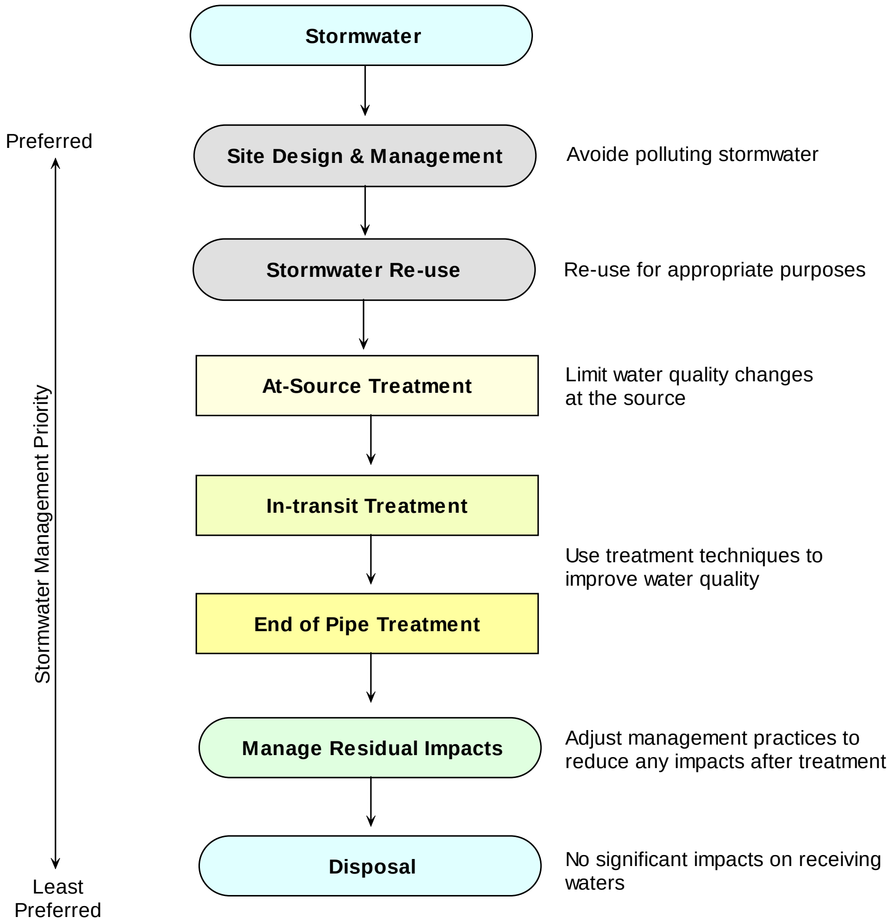


Figure 4.1
Stormwater Management Hierarchy

4.2 STORMWATER COLLECTION AND SEPARATION

The segregation of stormwater of different quality is a fundamental principle of stormwater management. For purposes of developing an overall strategy for the collection, treatment and disposal of stormwater, it is useful to consider three broad classes of stormwater:

- **‘Clean’ stormwater** is that water which has not been significantly degraded due to contact with pollutant generating surfaces (eg roof runoff);
- **‘Dirty’ stormwater** is that runoff which has been degraded due to contact with soil, manure, oils, etc;
- **‘Contaminated’ stormwater** is that water which has, or could, come in contact with processing wastes from the meat processing operations.

The goals of ‘best practice’ stormwater management should be to:

1. Ensure that 'clean' stormwater is kept away from areas where it could become contaminated.
2. Ensure that any stormwater from areas where contamination by meat wastes could occur is treated by the effluent treatment system.
3. Separate roof runoff from dirty runoff.
4. Keep dirty stormwater separate to the effluent treatment system.
5. Utilise clean stormwater as a resource to aid in meeting water demand for appropriate operational activities.
6. Ensure effluent is prevented from entering the stormwater system.

These goals can be achieved through managing operational practices to ‘avoid’ stormwater contamination while encouraging re-use of dirty stormwater, as indicated in Figure 4.1. Stormwater collection and separation strategies for various areas on abattoirs are listed in the following sections.

4.2.1 Separation of 'Clean' Runoff

Most abattoirs contain a large proportion of roof area, which may account for a significant volume of the site runoff. Because roof runoff is essentially one of the cleanest sources of runoff from an abattoir, separating roof runoff should be the first priority. There are three options for roof runoff management that abattoirs could adopt:

- complete separation from 'dirty' stormwater, and possible re-use – preferred option;
- incorporation into 'dirty' stormwater system – acceptable;
- incorporation into effluent system – least preferred option.

The advantages in separating roof runoff from other sources of stormwater are:

- Where the abattoir contains large roof areas and the effluent treatment system receives roof runoff, a significant reduction in the volume of effluent requiring treatment can be achieved by directing runoff away from the effluent treatment system.
- Although the volume of roof runoff may be insignificant compared to annual effluent production volumes at some abattoirs, separation of roof runoff is beneficial as it reduces the total effluent volume to be treated during wet weather. This is the period when effluent is most difficult to dispose of due to constraints on irrigation imposed by antecedent rainfall.

- As roof runoff is relatively clean, it may provide a water source for activities such as holding yard wash down or truck washing.

4.2.2 Management of 'Dirty' Runoff

The term 'dirty' refers to stormwater that has been exposed to sufficient quantities of sediment, nutrients or oils to render it degrading to a receiving aquatic environment. Unlike clean water management where the main objective is segregation, in 'dirty' areas stormwater management is principally concerned with minimising contact between water and the 'dirty' surface. The following strategies may be used to reduce the production of 'dirty' stormwater:

- Use of diversion drains up-slope of holding yards to divert clean runoff around the yards;
- Provision of bunding around areas that generate contaminants (such as solid waste stockpiles) to retain stormwater within the bunded area or to divert it into the appropriate treatment system;
- Provision of roofs over holding yards to minimise direct rainfall onto the yard;
- Minimising the use of hose-downs in areas such as under stock pens;
- Replacing hose-downs with dry sweeping;
- Ensuring vegetative cover on stock holding paddocks is not degraded by over-use.

4.2.3 Management of 'Contaminated' Runoff

The term 'contaminated' refers to stormwater that is produced in operational areas of the abattoir where there is the possibility of processing liquid and solid wastes combining with surface runoff. The goal of stormwater management on these areas is again to minimise the extent to which operational areas are exposed to direct rainfall, but also to ensure that the 'contaminated' runoff is segregated from 'dirty' and 'clean' stormwater runoff. In either case, contaminated runoff needs to be managed by the abattoir's effluent treatment system. Options that may aid in managing contaminated runoff include:

- Bunding of operational areas that may be located within a larger 'dirty' stormwater collection area (eg. a tallow loading area);
- Providing roofs over as much of the operational area as possible;
- Careful planning of the development of a new site or major extension so that 'contaminated' and 'dirty' stormwater areas can be separated into designated areas.

4.2.4 Stormwater Collection and Separation Strategies

The appropriateness of various stormwater management strategies for use on the various operational areas is summarised in Table 4.1. In this table, the following terms have been used:

- **Diversion Drain**: diverts relatively clean runoff around a potential source of dirty or contaminated runoff. Typically diversion drains would be used to divert runoff from areas up-slope of stock yards or holding paddocks;
- **Bunding**: to isolate a small area and allow for separate treatment of stormwater. In many instances bunding is used in conjunction with roofing to ensure that rainfall does not reach the area within the bund. Examples of this arrangement are for re-fuelling or tallow loading facilities;
- **Roofing**: is used to prevent rain falling on an area that is likely to produce ‘dirty’ or ‘contaminated’ runoff. This is most practical on relatively small areas (eg loading docks) but is often employed on stock holding areas immediately before the slaughter floor.

- **First Flush Capture**: is useful when there is a finite quantity of pollutant that is likely to fall onto the drainage area and the pollutant is readily transported in runoff (eg sediments, oil and dust). The primary aim of a first flush capture system is to retain the initial runoff containing the majority of pollutant. The first flush capture sump or dam must then be emptied (by appropriate treatment and disposal) prior to the next significant storm;
- **Contour Banks**: can be used in holding paddocks to prevent runoff concentrating and causing erosion.

Table 4.1
Appropriate Stormwater Collection and Separation Strategies

Operational Area	Diversion Drains	Bunding	Roofing	First Flush Capture	Contour Banks
Animal Handling Facilities					
Stock holding paddocks	✓	X	X	X	✓
Stock holding yards	✓	X	X	X	X
Stock holding pens	X	✓	✓	X	X
Pre-processing race	X	✓	✓	X	X
Yard and Ancillary Processing Areas					
Truck washdown area	X	✓	X	✓	X
Product loading dock	X	✓	✓	✓	X
Tallow loading area	X	✓	✓	✓	X
Hide salting and drying sheds	X	✓	✓	X	X
Open yard areas	✓	X	X	X	X
Workshop	✓	✓	✓	X	X
Roads and car parks	✓	X	X	✓	✓
Waste Storage and Disposal					
Solid waste storage and composting	✓	✓	✓	X	X
Solid waste disposal	✓	✓	X	X	X
Effluent Irrigation Area	X	X	X	X	✓
Fuel and Chemical Storage					
Fuel storage	X	✓	✓	X	X
Re-fuelling facilities	X	✓	✓	X	X
Chemical storage	X	✓	✓	X	X
Salt storage	X	✓	X	X	X
Roof Runoff	X	X	X	X	X

Design details of the various stormwater diversion and capture systems are set out in Chapter 6.

4.3 STORMWATER TREATMENT

There are a wide variety of treatment technologies suitable for stormwater treatment. However, the types of treatments appropriate for abattoir applications are generally methods which are inexpensive and treat a variety of pollutants. This section provides an introduction to the stormwater treatment technologies that are suitable for targeting specific stormwater pollutants from abattoirs. (Further technical details of individual treatment methods are provided in subsequent chapters.) The applicability of each of these treatment techniques to a particular abattoir will depend on its individual needs, site constraints and opportunities.

The various stages of stormwater treatment can be broadly divided into three categories:

1. **Primary treatment:** Stormwater treatments using screens and coarse filters that remove litter, coarse debris and coarse sediment.

2. **Secondary treatment:** Stormwater treatments that provide a greater degree of water quality treatment than primary treatments by means of skimming (for oils), settlement (for finer sediments) or filtration. Pollutants targeted by secondary treatments are fine sediment and associated attached nutrients, or oils and grease.

3. **Tertiary treatment:** These treatment techniques are principally concerned with removal of dissolved pollutants (usually nutrients) through biological uptake. Unlike in wastewater treatment this stage is not focussed on disinfection of water, although a limited degree of UV sterilisation may occur in pond/wetland systems.

Each of these three categories of stormwater treatment may be used in series to remove a range of pollutants, not unlike the use of primary and secondary treatment processes for abattoir effluent. In stormwater management, the use of these treatments in series is often referred to as a **‘treatment train’**.

The use of a ‘treatment train’ approach to stormwater management is particularly necessary to provide pre-treatment prior to stormwater discharge to biological stormwater treatment systems (tertiary treatments). Such a sequence of processes improves the efficiency of the subsequent stages of treatment. The ‘treatment train’ approach to stormwater management is also important to limit damage by a particular pollutant to a subsequent biological treatment system.

Figure 4.2 shows a typical relationship between pollutant type and treatment process. The figure shows that there is a relationship between the pollutant particle size and the type of treatment that can be used to remove that pollutant. A useful interpretation of the figure is that those treatments that have the highest hydraulic loading rates generally require the least area, but are only effective in removing particulates in the stormwater and not dissolved pollutants.

Adapted from CSIRO (1999)

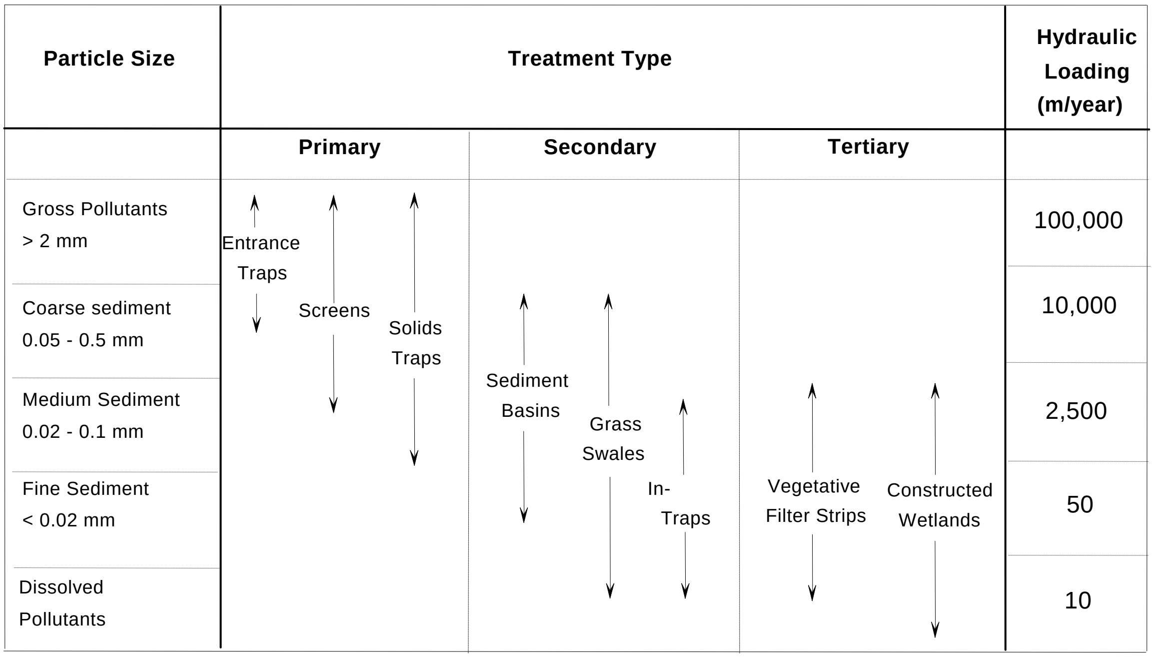


Figure 4.2
Applicability of Different Treatment Processes to Types of Pollutants

The treatment train approach often includes stormwater controls at various locations including the source of the stormwater degradation, while the stormwater is in-transit in the conveyance system and at the 'end of pipe' at the stormwater discharge location.

4.3.1 Types of Stormwater Treatments

Based on the site inspections conducted for this study and available literature on the performance of stormwater treatments, the types of stormwater treatments that are regarded as appropriate for abattoirs include:

Primary Treatment
- Grated pits and pit inlet pollutant traps,
- Solids screening traps.

Secondary Treatment
- Grass swales,
- Vegetative filter strips,
- Oil and grit separators,
- Sedimentation basins.

Tertiary Treatment
- Constructed ponds and wetlands,
- Evaporation ponds,
- Bio-retention/swales/basins.

The majority of these treatment technologies are capable of removing more than one type of pollutant. For example, biological treatment techniques are frequently applied in urban environments as components of 'water sensitive urban design' (WSUD) for new sub-divisions. WSUD involves measures to minimise and re-use stormwater as well as the use of a treatment train approach that may include primary, secondary and tertiary treatments. However, there is a large reliance on the use of biological systems such as grass swales, filter strips, bio-retention areas and wetlands. This style of treatment is regarded by many Councils and state government agencies as a preferred method for managing a wide variety of stormwater pollutants.

There are a wide variety of commercially available stormwater treatment devices that have been specifically designed for stormwater treatment in urban applications. These devices are typically focussed on removing gross pollutants and/or oils. Typically they are designed to have very high hydraulic loading rates. They have been proved to be very effective at removing gross pollutants and ensuring minimal head loss through the stormwater system. Although this style of stormwater treatment device is not appropriate for most abattoir applications, they are appropriate for areas such as car parks, truck washing areas, or as an end of pipe treatment for abattoirs with a predominantly piped stormwater system.

4.3.2 Selection of Appropriate Treatment Method

As outlined in Chapter 2, the different classes of stormwater pollutants (gross, floating, suspended or dissolved) require different treatment processes. Table 4.2 summarises the applicability of various treatment types to removing stormwater pollutants while Table 4.3 provides an assessment of the constraints/opportunities associated with each treatment technique. Constraints may include high capital costs, excessive maintenance requirements and land area requirements. Opportunities may include the ability to provide or improve habitat for aquatic and land animals while providing visual amenity for the abattoir. These factors may also improve public perception about the standard of environmental management of the abattoir.

Table 4.2 shows that the most suitable method by which nutrients may be removed from stormwater is through biological uptake by vegetation (eg bio-retention systems or constructed wetlands). However, as phosphorous is often attached to sediment, the use of a sedimentation basin may also be an efficient method for phosphorous removal.

Table 4.2
Selection Criteria for Stormwater Treatment Methods

Pollutants	Grated Pit / Screens	Grass Swale	Filter Strip	Oil Separator	Sediment Basin	Evaporation Pond	Wetland	Bio-retention Swale/Basin
Litter	✓	P	P	P	P	P	P	P
Pellet Manure	✓	X	P	P	✓	P	P	P
Coarse Sediment	X	✓	✓	X	✓	P	P	✓
Fine Sands	X	✓	✓	X	✓	P	P	✓
Clays	X	X	0	X	0	P	0	0
Total Nitrogen	X	0	✓	X	0	X	✓	✓
Total Phosphorous	X	0	✓	X	✓	X	✓	✓
Dissolved Phosphorous	X	X	✓	X	X	X	✓	✓
Oils and Hydrocarbons	X	X	X	✓	X	X	0	0
Grease	X	P	P	✓	P	X	P	P
Salts	X	X	X	X	X	✓	X	X
Chemicals	X	P	0	X	X	X	X	X

Legend

Inappropriate Technique	X	Partially Treatable	0
Appropriate Technique	✓	Pre-treatment Required	P

Table 4.3
Opportunities and Constraints for Stormwater Treatment Methods

Constraints / Opportunities	Grated Pit / Screens	Grass Swale	Filter Strip	Oil Separator	Sediment Basin	Evaporation Pond	Wetland	Bio-filtration Swale/Basin
Capital Costs	✓	✓	✓	X	X	X	X	✓
Frequency of Maintenance	X	✓	✓	✓	✓	X	0	0
Area Requirements	✓	0	✓	✓	X	X	X	X
Ecological Habitat Provision	0	✓	✓	0	0	X	✓	0
Visual Amenity	X	✓	✓	0	X	X	✓	0

Legend

Desirable / Benefits	✓
Undesirable /Disadvantages	X
Neutral / Not applicable	0

4.3.3 Applicable Treatment Methods for Abattoirs

Based on criteria set out in Tables 4.2 and 4.3, Table 4.4 shows stormwater treatment methods that are appropriate for various operational areas on abattoir sites. Further design features for these systems are outlined in Chapter 7.

Table 4.4
Stormwater Treatment Methods for Abattoir Operational Areas

Operational Area	Grated Pit / Screens	Grass Swale	Filter Strip	Oil Separator	Sediment Basin	Evaporat ion Pond	Wetland	Bio-filtration Swale/Basin
Animal Handling Facilities								
Stock holding paddocks	X	✓	✓	X	✓	X	✓	X
Stock holding yards	✓	✓	✓	X	✓	X	✓	X
Stock holding pens	✓	X	X	X	✓	X	X	X
Yard and Ancillary Processing Areas								
Truck washdown area	X	✓	✓	✓	X	X	X	X
Product loading dock	✓	X	X	✓	X	X	X	X
Tallow loading area	X	X	X	✓	X	X	X	X
Hide salting and drying sheds	X	X	X	X	X	✓		X
Open yard areas	✓	X	X	✓	X	X	X	X
Workshop area	✓	X	X	✓	X	X	X	X
Roads	✓	✓	✓	✓	✓	X	✓	✓
Car parks	✓	✓	✓	✓	X	X	X	✓
Waste Storage and Disposal								
Solid waste storage and composting	✓	X	✓	X	✓	X	X	X
Solid waste disposal	X	X	✓	X	X	✓	✓	X
Effluent Irrigation Area	X	X	✓	X	✓	✓	✓	X
Fuel and Chemical Storage								
Fuel storage	X	X	X	X	X	X	X	X
Re-fuelling area	X	X	X	✓	X	X	X	X
Chemical storage	X	X	X	X	X	X	X	X
Salt storage	X	X	X	X	X	✓	X	X

Table 4.4 shows that of all the stormwater treatment techniques examined, vegetative filter strips, sedimentation basins and grass swales are the most suitable for treating runoff from a range of different areas.

5.0 OPERATIONAL AREAS

Table 5.1 summarises the applicability of various stormwater treatment, re-use or disposal strategy to abattoir operational areas. The subsequent sections of this chapter provide further details of the ways in which stormwater from various areas of an abattoir should be managed. While these recommendations are considered 'best practice' for stormwater management, their suitability to a particular abattoir depends on site layout and operational constraints.

Table 5.1
Applicability of Stormwater Treatment, Re-use and Disposal Strategies to Abattoir Operational Areas

Operational Area	Capture & Re-use	Fully Retain	Treat & Discharge	First Flush Capture
Roof Areas	✓			
Animal Handling Facilities				
Stock holding paddocks	✓		✓	
Stock holding yards			✓	
Stock holding pens			✓	
Yard & Ancillary Processing Areas				
Truck washdown area			✓	✓
Product loading dock				✓
Tallow loading area			✓	✓
Hide salting and drying sheds		✓		
Open yard areas			✓	
Workshop		✓		
Roads and car parks			✓	✓
Waste Storage & Disposal Areas				
Solid waste storage and composting			✓	
Solid waste disposal			✓	
Effluent Irrigation Area			✓	
Fuel & Chemical Storage				
Fuel storage		✓		
Re-fuelling facilities		✓		
Chemical storage		✓		
Salt storage		✓		

5.1 ROOF AREAS

Roof areas are a relatively clean source of runoff, often only collecting dust that has accumulated on between rainfall events. Management strategies that could be implemented include:

Stormwater Collection and Separation

- Roof runoff separately piped into a 'clean' runoff storage dam or rainwater tank.
- Roof runoff directly discharged to a pervious area such as gardens, or stock holding paddocks. Additionally, the runoff may be piped directly into an off-site drainage line.
- Roof runoff should be prevented from entering effluent treatment system.

Stormwater Treatment

- Generally none required.

Stormwater Re-use

- Supplementary supply areas that do not require potable water.
- Irrigation of paddocks or gardens.
- Washdown of trucks.

5.2 ANIMAL HANDLING FACILITIES

5.2.1 Stock Holding Paddocks

Stock holding paddocks are semi-intensive livestock areas that do not require the stormwater controls that would be required for more intensive applications such as feedlots or stock holding yards. Generally, the level of stormwater management for these areas will depend on the condition of the vegetative cover. Paddocks with good pasture cover will require no stormwater controls, while paddocks with little grass cover are likely to generate sediment laden stormwater and the following stormwater management practices should be considered:

Stormwater collection and separation strategies

- Use of diversion drains to direct runoff from up-slope areas around the holding paddocks.
- Provision of contour banks to slow runoff velocity and reduce sediment transport within the paddock.
- Use of diversion drains to direct runoff to areas/paddocks with good vegetative cover and to prevent water run-on to operational areas.
- Use of sediment fencing on the down slope boundary of the paddock, as a temporary measure if vegetative cover on the paddock is poor.

Management options

- Exclusion of stock from defined drainage lines bisecting paddocks, in order to promote good permanent vegetative cover on these areas that are subject to concentrated flows.
- Rotational grazing to allow recovery time before the next mob is placed in a paddock.

Stormwater Treatment

- Use of grass swales or vegetative filter strips on drainage lines carrying concentrated flows. (Note that these areas will need to be fenced to prevent grazing and trampling by stock.)
- Use of vegetative filter strips on the paddock boundary where runoff discharges from the site. (Filter strips will need to be fenced to prevent grazing and trampling by stock.)

5.2.2 Stock Holding Yards

Stock holding yards are subject to more intensive use than holding paddocks, and stormwater management issues are often more similar to those faced by feedlots or saleyards. Stock holding yards may be either fully sealed or unsealed.

Note:

Stock holding yards are a major problem area for abattoirs as first flush treatment does not work effectively for unsealed yards because they generate pollutants over the duration of a storm, much like feedlots.

Stormwater Collection and Separation

- Sealing of yards to prevent excess soil being transported in runoff.
- Using surface reinforced turf (concrete or plastic with large voids) to reinforce the surface while allowing runoff to soak into the soil.
- Use of diversion drains to prevent runoff from up-slope areas entering the holding yards.
- Separation of runoff from holding yards from 'contaminated' stormwater runoff.
- Using a first flush runoff collection system for sealed yards.
- Provision of roofs over holding yards to eliminate the generation of ‘dirty’ stormwater.

- Separation of roof runoff from holding yard runoff.

Stormwater Treatment

The types of pollutants generated from holding yards can be managed using conventional stormwater treatment techniques. Therefore, the runoff does not necessarily require treatment by the effluent treatment system. Suitable conventional stormwater treatment methods include:

- First flush systems,
- Sedimentation basins,
- Vegetated filter strips,
- Stormwater capture for irrigation.

Stormwater Re-use

- Utilising roof runoff to provide initial hose down of dirty animals.
- Re-use of stormwater runoff from the yard surface for irrigation.

Management Options

For a typical meat processing plant, water use for stockyards, paddocks, pens and the race may total 25% of total plant water use (Meat & Livestock Australia, 2002). Water that is used for stock watering, stock preliminary washing, yard hose-down and delivery truck washing may contribute to additional runoff from stock holding yards. Minimising water use in such areas will aid in reducing runoff generation and may be accomplished by:

- Reducing the frequency of holding yard hose downs.
- Minimising receipt of very dirty stock.
- Minimising stormwater pollutant generation by dry cleaning yards before washing, or avoiding washing altogether.

5.2.3 Stock Holding Pens

Stock holding pens for sheep are generally roofed areas that have a mesh floor to allow manure to fall through to a sealed surface. Because the area is roofed, hose-down of the area underlying the pens is the main source of runoff. This runoff is usually directed to the effluent treatment system.

Stormwater Collection and Separation

- Diversion of holding pen roof runoff to ‘clean’ storage dams.
- Where hose-downs are used, bunding (or appropriate drainage) should be used under pens to prevent runoff from moving onto other operational areas. This runoff should be separated from all other site runoff.

Stormwater Treatment

- Because of the small volume of runoff likely to be produced in this area, the runoff could be incorporated into the effluent treatment system after screening to remove manure pellets.

Management Options

- Using dry scraping of manure rather than hose-downs to minimise the production of 'dirty' stormwater or minimise inflow to the effluent treatment system (this will necessitate sufficient head room underneath the pens for machinery movement)

5.3 YARD AND ANCILLARY PROCESSING AREAS

5.3.1 Truck Washdown Areas

Truck washdown areas are a potential source of sediment, oils and detergents. The following stormwater strategies may be used within these areas:

Stormwater Collection and Separation

- Washing areas should be bunded, or graded to drain into a collection sump in order to prevent runoff from entering other areas that are less subject to pollution.

Stormwater Treatment

- Runoff should be treated to remove sediment and oil at the source.

Stormwater Re-use

- Meat & Livestock Australia (2002) have estimated that vehicle washdown could account for approximately 4% of typical total plant water use. Therefore, re-use of roof water from other areas would be appropriate for truck washdown.

Management Options

- If possible, exclude washing of vehicles from the facility.

5.3.2 Tallow Loading Area

Stormwater Collection and Separation

- The tallow loading area should incorporate a roll-over bund, to prevent any spills from escaping to adjacent vehicle movement areas.
- If unroofed, a first flush washdown system should be installed to capture any grease that has collected in this area.

Management Options

- Tallow is generally kept in heated vats and loaded onto tankers. Therefore it is important to ensure that these loading areas are either bunded, or drain to a specified location where the tallow can be directed into the effluent treatment system, rather than the stormwater system.
- Locate tallow loading areas in parts of the facility where stormwater would drain to the effluent treatment system.
- Place the loading facility under a roof in order to exclude incident rainfall.
- If unroofed, ensure that a cut-off valve can be activated to isolate the stormwater system when tallow is being loaded onto tankers.

5.3.3 Hide Salting and Storage Areas

The use of salt for drawing the fluids out of hides is a major concern for stormwater management as salts are not easily removed from water and can cause significant damage to the environment.

Salt – A Major Problem for Abattoirs

Salinisation poses one of the greatest risks to the environment in Australia. Salt is difficult and expensive to dispose of and the various state environmental authorities are becoming increasingly vigilant in policing its use and disposal.

The following stormwater management strategies may be utilised in such areas:

Stormwater Collection and Separation

- Salted hides should be fully enclosed in a roofed area.
- Rotary mixers should be fully enclosed in a roofed area.
- Salted hides should be stored within an area containing bunding or drainage to capture the fluids draining from the skins.
- Any brine generated off the hide salting areas should be stored separately to all other stormwater in a sealed plastic tank, prior to treatment/disposal.
- Drainage from areas using chemicals for wool removal should be bunded off from hide salting areas.
- Brine should not be disposed of into the effluent treatment system.

Brine Treatment

- Brine may be converted into salts through the use of evaporation ponds or similar technologies.

Management Options

- Dry sweeping should replace the use of hose-downs to ensure that minimal volume of brine is produced.
- Brine should not be diluted – better to keep a smaller volume of concentrated brine.
- Consideration could also be given to conducting the hide salting off-site at a contractor's facility.

5.3.4 Internal Yard Areas

The quality of water draining from internal yard areas may vary considerably depending on the location of the area within the plant and whether the yard is sealed or unsealed.

Stormwater Collection and Separation

- Often yards are used to transport processing wastes between processing buildings. The runoff from these yards should be directed into the effluent treatment system.
- Where yards are used to transport processing wastes between buildings, it is desirable for these areas to be roofed to minimise contamination of relatively clean runoff.

Stormwater Treatment

- Runoff from sealed and unsealed yards in areas where contamination is not likely should be directed into the stormwater drainage system for disposal.

- Stormwater inlet pits should be grated to stop coarse litter from entering.
- Yard runoff may be treated by oil/grit separator if the yard drainage is piped.

Management Options

- Avoid the vehicular transportation of liquid and solid wastes across open areas that do not drain to the effluent treatment system.
- Use fully enclosed bins for transport of wastes.
- Where transport across an open yard is unavoidable, use low 'roll-over' bunding to separate designated transport corridors that drain to the effluent treatment system.

5.3.5 Roads and Car Parking Areas

Stormwater Collection and Separation

- Runoff diversion drains should be installed up-slope of unsealed vehicle parking areas

Stormwater Treatment

- Access into the abattoir will be frequently used by trucks transporting livestock. Such movements may transport manure and sediment onto the site. Therefore, the runoff from these roads should be directed to some form of stormwater treatment before entering any drainage line.
- Runoff from sealed and unsealed roads in areas where contamination is not likely should be directed into pervious areas such as paddocks, preferably using grass swales.
- In situations where transport trucks are frequently bringing sediment and manure onto the site, the runoff from these roads should be passed through a solids screen before water is diverted to a paddock. If the drainage is likely to flow direct to a drainage line, a sedimentation basin should also be incorporated into the stormwater treatment process.
- Grass swale drains may be used adjacent to roads instead of kerb and guttering.
- Runoff from sealed parking areas with piped stormwater drainage should be treated to remove oil and sediment.
- Runoff from sealed parking areas with no piped drainage should be directed into a grass swale, vegetative filter strip or sedimentation basin to remove pollutants.
- Unsealed parking areas should use grass buffer areas down-slope, or direct runoff to permeable areas such as paddocks.
- Unsealed parking areas on steeper slopes should use contour banks to reduce scour velocities and encourage dispersed sheet flow.
- Stormwater inlet pits should be grated to stop coarse litter from entering.
- Road runoff may be treated by oil/grit separator if road drainage is piped.

5.4 WASTE STORAGE AND DISPOSAL AREAS

5.4.1 Solid Waste Storage Areas

Stormwater Collection and Separation

- Runoff should be prevented from moving off the area by use of bunding.
- Storage areas should be roofed to prevent contact with rainwater.

Stormwater Treatment

- Runoff should be directed to the effluent treatment system.

5.4.2 Composting Areas

Solid wastes from the DAF and other material is often naturally composted or fed to worm farms at abattoir sites. However, as rainfall moves through a compost heap it produces leachate that may contain significant concentrations of nutrients.

Stormwater Collection and Separation

- Provision of bunding around compost areas to prevent surface water from moving off-site.
- Utilising diversion drains up-slope of composting areas to prevent water run-on.
- Utilisation of underdrainage in composting areas to collect leachate for separate treatment and disposal.
- Provide roofing above composting areas.

Stormwater Treatment

- Leachate should be treated by the effluent treatment system.
- A grass buffer strip should be placed between the composting area and any waterway.

Management Options

- Possible use of vertical composting units (VCU's) in areas susceptible to groundwater contamination.

5.4.3 Effluent Irrigation Areas

Effluent irrigation areas receive secondary treated abattoir effluent that contains significant concentrations of nutrients. Proper irrigation management will ensure that irrigated areas are not overloaded with nutrients, particularly phosphorous. Some state environmental agencies seek to impose a requirement for an irrigation tailwater dam to collect any runoff. However, this approach leads to a situation in which additional water must be disposed of, usually at a time when the irrigation application rate is limited by high soil moisture levels or low evapotranspiration rates. Stormwater management practices that may be used to manage runoff from these areas include:

Stormwater Collection and Separation

- Diversion banks to ensure that up-slope runoff does not enter the irrigation area.
- Providing contour banks on steeper slopes to disperse runoff and minimise erosion.
- Collecting runoff in an irrigation tailwater dam (as a last resort).

Stormwater Treatment

- Providing a grassed buffer strip along the down-slope boundary or between the irrigation area and a watercourse.
- Converting an irrigation tailwater dam into a wetland.
- Direction runoff into a woodlot or runoff disposal area that is maintained with a good grass cover.

Stormwater Re-use

- Irrigating runoff collected in the tailing dam to pasture or the buffer strip.

Management Options

- Undertaking appropriate irrigation and crop management to ensure that the soil is not overloaded with nutrients and runoff is minimised.

5.5 FUEL AND CHEMICAL STORAGE

5.5.1 Fuel Storage

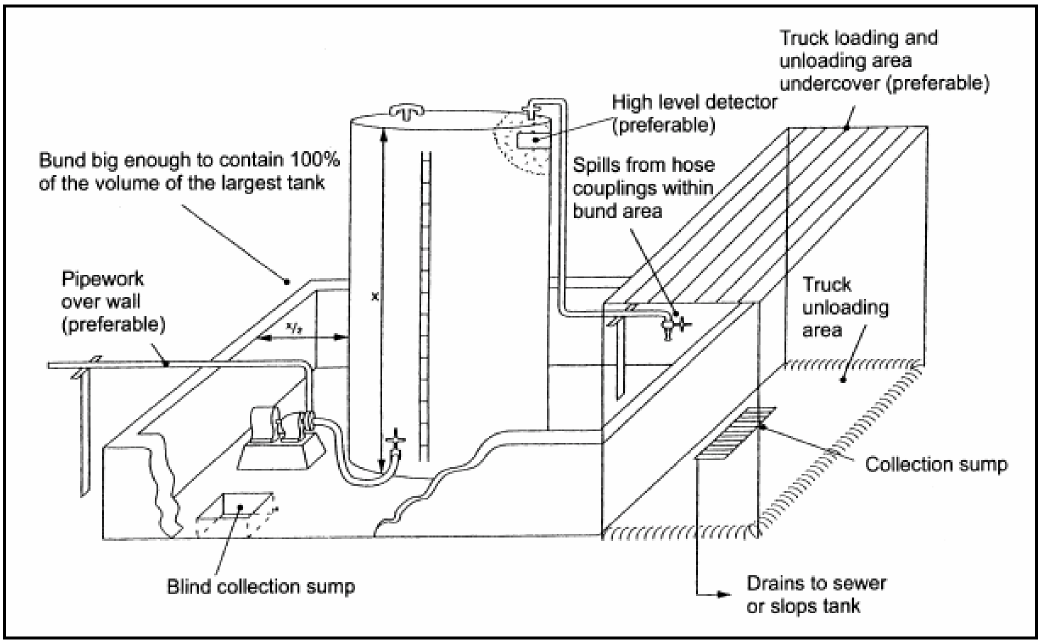
Bulk fuel storages are a potential source of hydrocarbon pollution in stormwater and should be subject to a spill management plan. Figure 5.1 shows a typical arrangement for the management of bulk liquid storage tanks. Under the Australian Standards (AS 1940-1993 5.9.2, AS 3780-1994 5.7.2, AS 4452-1997), a bund must be designed to hold at least 100% of the capacity of the largest tank, with an additional allowance for rainwater accumulation.

Stormwater Collection and Separation

- Bulk fuel should ideally be stored in bunded areas to prevent fuel from entering the stormwater system;
- Fuel storage areas should be roofed.

Management Options

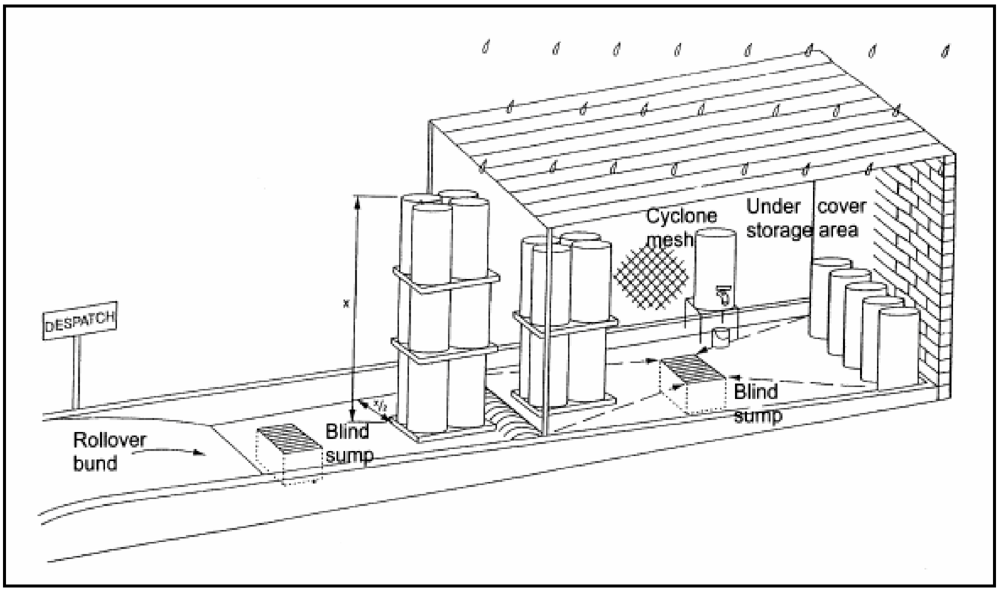
- Re-fuelling of vehicles should be undertaken in bunded areas, or in areas where the runoff may drain to a specified location where a spill can be effectively managed.
- A spill management procedure should be developed for fuel storage areas containing bulk liquid storage tanks.
- Spill control equipment should be kept close to the fuel storage areas.



Source: NSW EPA website

Figure 5.1
Bunding for Bulk Fuel/Chemical Storage

For areas containing liquids in drums, the bunded area should contain 25% of the total volume of stored liquids. Figure 5.2 shows a typical example of a bunding arrangement for the storage of drums and containers.



Source: NSW EPA website

Figure 5.2
Bunding for Fuel/Chemical Drum Storage

5.5.2 Chemical Storage

Abattoirs use various chemicals for cleaning and for the removal of hair from hides.

Management Options

- Chemicals should be placed in areas provided with bunding and sufficient capacity to hold all of the container contents, should the container rupture.
- If there is any opportunity for chemicals to enter the stormwater system, say during a chemical spill, the stormwater should be directed away from biological stormwater controls such as wetlands and filter strips.

6.0 STORMWATER SEPARATION AND COLLECTION

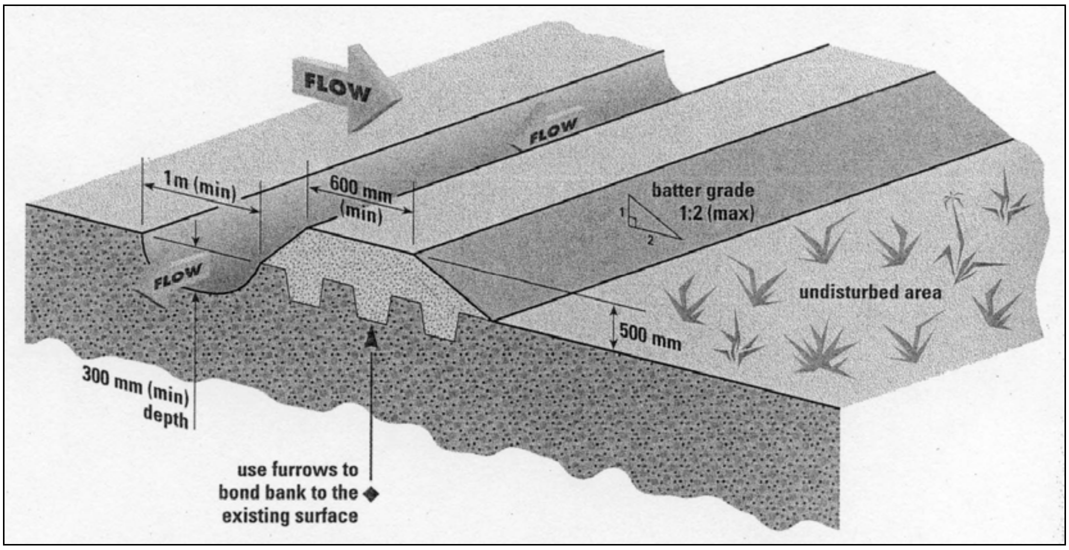
This section describes principles behind the design of stormwater separation and collection technologies. Most of the systems described below are commonly used to control runoff from cultivated land or construction sites. Further details are contained in such manuals as:

- *"Soil Erosion and Sediment Control – Engineering Guidelines for Queensland construction Sites"* (1996), Institution of Engineers, Australia, Queensland Division.
- *"Managing Urban Stormwater: Soils and Construction"* (1998), NSW Department of Housing.

6.1 RUNOFF DIVERSION DRAINS

Diversion drains are used to direct runoff from up-slope areas to another designated location. Diversion drains should be capable of diverting runoff around operational areas during large storms; otherwise the operational area may be flooded on a regular basis.

Diversion drains are suitable for conveying large flows (typically up to the 20 year average recurrence interval [ARI] storm). The velocity in the drain should be kept less than the maximum scour velocity of 0.6 m/s for bare earth, or 2.0 m/s for well grassed drains. Diversion drains are used for slope ranges between 1.5% - 15%. If greater flow velocities are likely due to the drain being constructed on a steep slope, suitable reinforcing of the drain bed with jute mesh or rock lining would be required. Typical design details of a diversion drain, reproduced from Institution of Engineers Australia (1996), are shown in Figure 6.1 below.



Source: Institution of Engineers Australia, 1996

Figure 6.1
Typical Diversion Drain Design

For areas that require less protection, a broad based bank may be used to replace a diversion drain. As a general rule, broad based graded banks are sufficient to carry flows up to the 10 year ARI storm, with a maximum scour velocity of 0.6 m/s for bare earth channels. Compared to diversion drains, broad-based banks are only suitable on areas with a slope range of 1% to 6%.

6.2 FIRST FLUSH COLLECTION

First flush collection is an appropriate method by which the runoff from the initial portion of the storm is collected separately to runoff from the latter portion of the storm. The logic behind first flush separation is that the initial portion of the storm is likely to produce a greater pollutant load from certain areas. Therefore, it is important to capture this runoff and subsequently direct it into an appropriate treatment system. (For abattoirs, it is likely that the most appropriate treatment will be the effluent treatment system.) The runoff from the latter portion of the storm would be less polluted and is treatable by using normal stormwater treatment techniques.

First flush separation is not, however, applicable to stormwater management on all areas of an abattoir, as some areas tend to produce pollutants in runoff at a constant rate. The type of first flush system used will also depend on the style of stormwater system (eg piped versus open drains) and the area being treated.

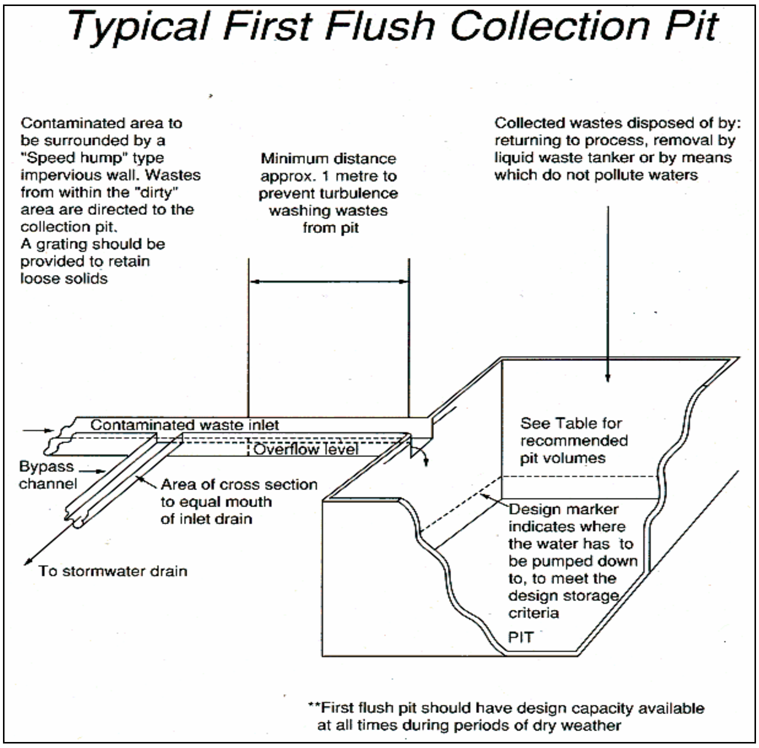
The major objectives of a first flush system are to ensure that:

- all the initial runoff is captured and retained, with any subsequent runoff directed away from the first flush storage;

- all captured runoff is removed from the first flush capture device (pit or dam) before the next significant storm

First flush capture can be accomplished by using a 'dead end' storage as shown in Figure 6.2. Such a system works by directing runoff into a storage tank which is configured so that, once full, the runoff is directed to a bypass system into the general stormwater drainage system. Important details in the design of first flush systems include:

- Weir levels must be designed so that runoff is diverted into the general stormwater system only after the first flush water has filled the collection pit or basin.
- There should be adequate separation distance between the collected first flush water and the bypass channel to minimise entrainment of captured stormwater by bypass flows.
- The volume of the collection pit or basin should be sufficient to capture most of the pollutant load expected from the operational area. Although there is little information on the amount of rainfall needed to cleanse a polluted surface, a first flush storage of 10-20 mm rainfall over the catchment area being treated is generally considered appropriate.
- Provision should be made for removal (and treatment) of the contents of the first flush basin prior to the next significant storm event. The time before the next significant storm will depend upon the climate of the particular locality and there are no strict guidelines regarding the required rate of emptying of a first flush pit. Five to ten days should be taken as a guide.



Source: NSW EPA website

Figure 6.2
First Flush Collection System

6.3 BUNDING

A bund is an impervious embankment constructed of concrete, earth or other suitable material that provides a barrier to retain a liquid. Two types of bunds are commonly used in managing stormwater:

- Low 'roll-over' bunds that allow vehicle movement whilst separating stormwater from adjacent areas with different pollutant characteristics (see Figure 5.2).
- Walls or pits designed to fully surround a fuel tank or other source of liquid pollutants (see Figure 5.1). The extent of bunding will depend on the level of risk associated with the liquid being stored. Typically the bund must provide sufficient storage capacity to be capable of retaining the entire volume of the tanks/drums stored within the bund. Where applicable, the construction of bunds must comply with the requirements of the relevant Australian Standards.

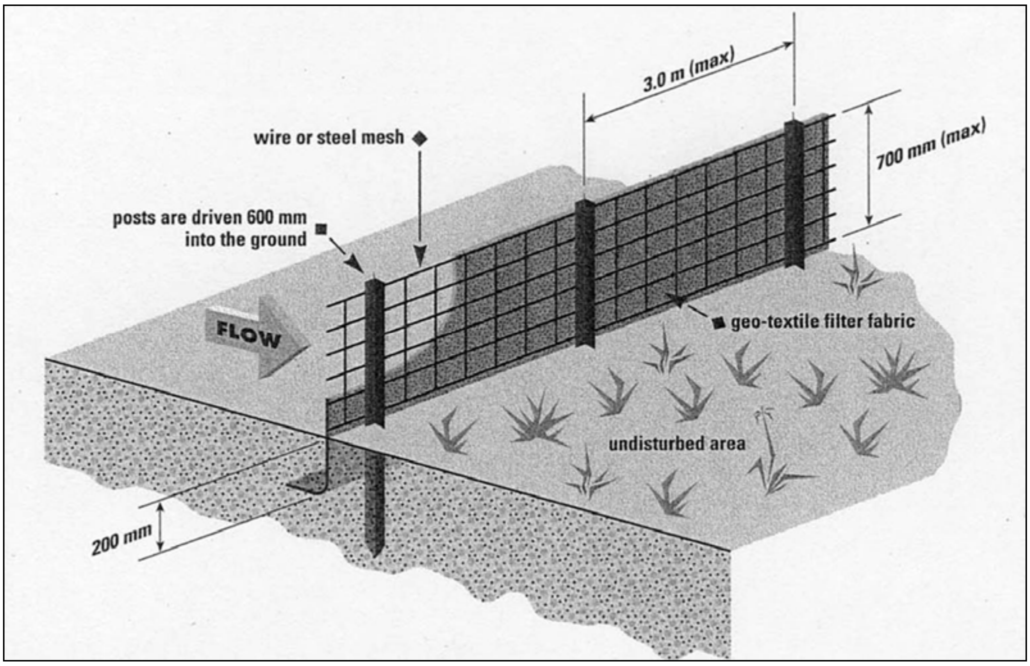
6.4 SILT CONTROL FENCING

Silt control fencing is a temporary sediment control technique used to capture sediment from areas of disturbed soils (eg recent earthworks). Its use is appropriate for areas that are likely to generate sediment due to recent disturbance or loss of ground cover, and particularly suitable if those areas are located near a drainage line. The advantages of using sediment fencing include:

- low capital cost;
- restrict flow of sediment;
- aid in reducing wind and water erosion.

The following design principles (as illustrated in Figure 6.3) should apply to the use of sediment control fencing:

- Fencing must be securely staked into the ground (up to 200 mm depth) to prevent runoff from scouring under the fencing.
- Posts should be driven 600 mm into the ground, with 3 m maximum spacing between posts.
- Fence height should be no greater than 700 mm.
- The fencing may be used on gentle to very steep slopes.



Source: Institution of Engineers Australia, (1996).

Figure 6.3
Silt Control Fencing Installation

7.0 STORMWATER TREATMENT

The following sections describe the treatment technologies considered appropriate for use on abattoir sites and provide basic concept details for their design. Design methods are generalised to enable approximate sizing of stormwater treatment systems, but will require further validation using suitable engineering design criteria.

Further details of design criteria for stormwater treatment systems are set out in a number of reference manuals such as:

- *"Australian Runoff Quality",* (draft 2003), Institution of Engineers Australia, Canberra;
- *"Urban Stormwater: Best Practice Environmental Management Guidelines",* (1999), CSIRO for Victorian Stormwater Committee, Melbourne;
- *"Managing Urban Stormwater: Treatment Techniques"*, (1998), NSW EPA, Sydney.

7.1 INLET PIT GRATES AND SCREENS

These consist of sturdy metal screens that cover stormwater pit inlets and prevent large debris from blocking the stormwater system or treatment devices located within stormwater collection pits. Grates are particularly useful in trapping large litter items, and would be the most appropriate form of litter management on abattoirs.

Some commercially available devices can be retro-fitted with oil absorbent pillows and filter fabric to remove fine sediment.

Application
- Source control;
- Stormwater pits.

Advantages
- Inexpensive;
- Reduces drain blockages.

Disadvantages
- Litter collected on grate needs to be removed;
- If grate becomes substantially blocked, localised flooding could occur;
- Only retains large items of rubbish.

Design Considerations
Grates on pits should be located where the stormwater system is regularly blocked by debris, or in areas that are likely to generate the greatest amount of litter.

7.2 SOLIDS TRAP / SCREEN

Solids screens may take many forms, although their principal purpose is to remove coarse solids from the stormwater. A typical sample is shown in Figure 7.1.

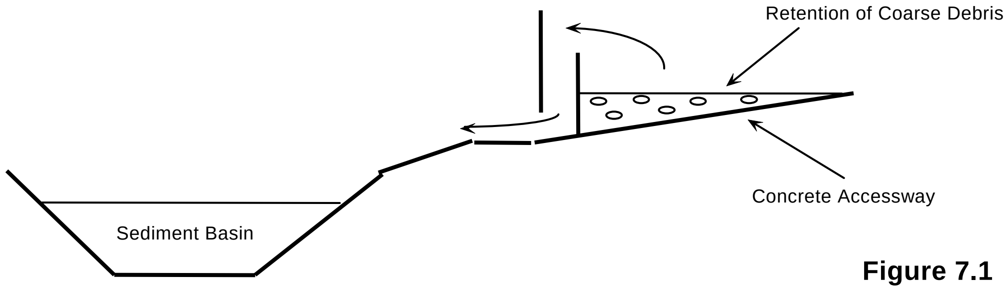


Figure 7.1
Schematic Diagram - Solids Trap

Application

- Removal of gross solids (such as manure pellets) on intensive areas such as holding yards and pens;
- Pre-treatment to end of pipe treatments such as sedimentation basins.

Advantages

- Removes solids such as manure, litter and coarse sediment;
- Reduces contact time of manure with water thereby minimising nutrient leaching;
- Reduces the need for de-sludging of sedimentation dams and swales/drains, thereby allowing these treatment systems to work more effectively and save on maintenance costs.

Design Considerations

- Design should allow flow to bypass directly to sedimentation basin or wetland if the screen becomes blocked.
- Design should allow cleaning by front-end loader or similar.
- If the trap is undersized it will require frequent cleaning.
- Screen opening size typically 20 – 50- mm.

7.3 GRASS SWALES

Swales are essentially grass-lined channels that serve as an alternative to a concrete channel or kerb and guttering. Their principal use is therefore to convey runoff, although they are often useful as a pre-treatment for runoff before it arrives at a more sophisticated treatment system (such as a wetland or bio-retention swale/basin).

Application

- Alternative to kerb and guttering for roads,
- Alternative to pipes for runoff conveyance.

Advantages

- The main advantage of grassed swales is that flow velocities are reduced through contact with the grass, which aids in reducing erosion. The reduced velocity also allows coarse fractions of the suspended particles to settle out and/or become trapped. The efficiency of the vegetation in removing sediment ranges from 25% to 80% depending on the grading of the sediment contained in the stormwater.
- At very low flows swales may also aid in reducing some of the nutrients contained within the stormwater.
- Low maintenance costs compared to wetlands and infiltration/bio-retention trenches.
- Cheaper construction costs compared to kerb and guttering.

Limitations

- Not suitable for conveying flows that contain concentrated pollutants that would kill the grass.
- Requires larger land area than kerb and guttering.
- Limited application in shaded areas or areas regularly drought affected.
- More maintenance intensive than kerb and guttering.
- Vehicles must be excluded to avoid damage.

Guidelines for Designing Swale Drains

- ***Geometry*** – preferred geometry should minimise sharp corners with parabolic or trapezoidal shapes and side slopes no steeper than 1:3 (V:H).
- ***Longitudinal Slope*** – should generally be in the range of 2-4% to promote uniform flow conditions. Check dams should be installed if slopes exceed 4% and under-drains installed if slopes are less than 2%, or swale is subjected to low flows containing salts.
- ***Swale Width*** – should be limited to no more than 2.5 m, unless structural measures (eg flow spreader banks) are used to ensure uniform spread of flow.
- ***Maximum Flow Velocity*** – should be less than 0.3 m/s for the 1 year ARI event to aid in sedimentation and a maximum velocity of 1.0 m/s for the 20 year ARI event. A high flow bypass could be installed if velocities in excess of 2.0 m/s are anticipated, although a well designed grass swale would safely convey this velocity for short durations.
- ***Concentrated flows*** - where the swale receives a low flow with pollutant concentrations that may damage the grass, this flow should be conveyed over a concrete dish drain in the middle of the swale, or through an underdrain.

7.4 VEGETATIVE FILTER STRIPS

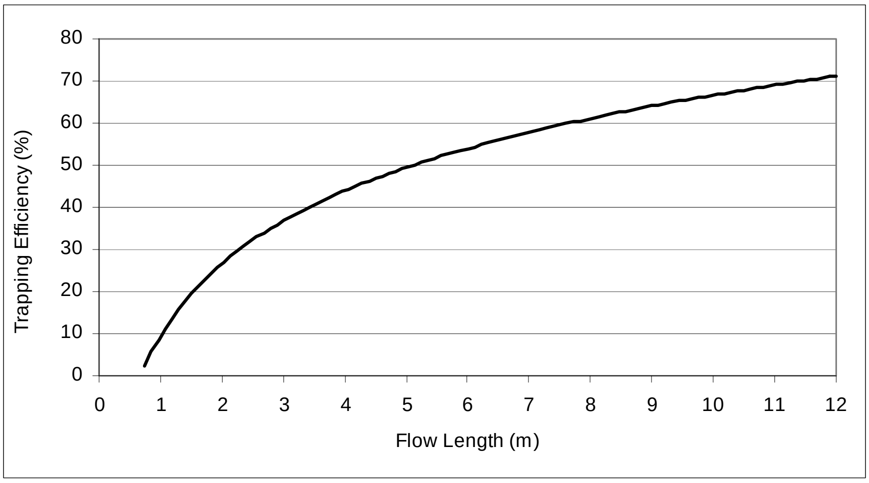
Vegetative filter strips are areas that treat overland flow before it enters the main site drainage system or creek. They are designed so that the stormwater flows as shallow sheet flow across the entire width of the filter strip, which aids in the deposition of sediment and associated removal of nutrients. They may also remove significant proportions of dissolved nutrients through plant uptake, microbial breakdown and retention in the soil profile.

Application

- Stormwater treatment (end of pipe);
- Use as a buffer between an operational area and waterway/drain (source control)

Advantages

- Can aid in reducing flow velocity before discharge to a waterway;
- Exhibit consistency in nutrient and sediment removal as long as the vegetative filter strip is maintained;
- Require much less maintenance than wetlands;
- Are capable of removing dissolved nutrients such as nitrogen and ortho-phosphates;
- Exhibit sediment removal rates of up to 70% with relatively short vegetative filter strip lengths (Figure 7.2).



Adapted from: Wong and McCuen (1982)

Figure 7.2
Sediment Trapping Efficiency of Vegetative Filter Strips

Limitations

- Not suitable for areas with steep slopes (>10%);
- Nutrient removal is less efficient in areas containing very sandy soils or heavy clays.
- Efficiency is limited if flows become concentrated within the vegetative filter strip.

Guidelines for Designing Vegetative Filter Strips

- ***Longitudinal Slope***- a vegetative filter strip may be used on slopes up to 10%, although ideal conditions are slopes between 1% and 5%.
- ***Flow distribution***- all flow entering the vegetative filter strip needs to be evenly distributed across its width. This can be accomplished by using a gravel bund or flow distribution trench.
- ***Maximum Flow Velocity***- a maximum flow velocity of 0.3 m/s will aid sedimentation.
- ***Flow depth***- a design flow depth of 12 mm should be adopted, which will be dependent on the slope and flow rate onto the filter strip.
- ***Filter strip length***- a length of greater than 10 m will aid in removing sediment and associated phosphorous, with greater lengths (30 m) required for significant removal of soluble nutrients.
- ***Vegetation type***- non-clumping grasses such as Kikuyu should be used.

7.5 OIL AND GRIT SEPARATORS

The treatment of oil should be undertaken close to the source because the efficiency of oil collection is highest where the stormwater flow is least. As a result, the required size of a device located near the source is proportionately smaller than a device located further downstream in the stormwater network system. The most common types of oil and grit separators are either a triple interceptor pit or, where a greater treatable flow rate is required, a commercially available device.

A triple interceptor pit comprises three underground chambers designed to remove coarse sediment and retain oils (Figure 7.3). The first chamber removes coarse debris, the second traps floating oils and the third is used to collect and disperse flow. It is important that high flows are bypassed around this device so that turbulent conditions are not created which may resuspend grit or entrain floating oil.

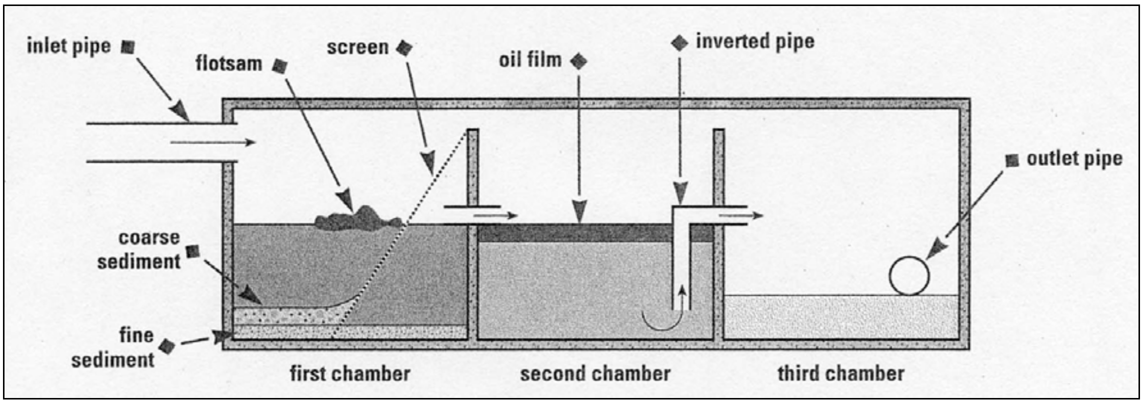


Figure 7.3
Simple Oil and Grit Separator

Application

- Source control;
- Truck washdown bays;
- Maintenance workshops.

Advantages

- Appropriate for areas containing vehicles or workshops;
- Can aid as a spill control device in refuelling areas;
- May be retro-fitted into the existing drainage system.

Disadvantages

- Requires regular cleaning to ensure continued collection efficiency;
- Trapped debris may release dissolved pollutants into the stormwater;
- Trapping performance is directly related to maintenance frequency;
- High capital costs associated with commercial products.

Design Considerations

- Oil and grit separators should be located as close to the oil source as possible to increase the efficiency of the device.

7.6 SEDIMENTATION BASINS

Sedimentation basins are widely used to reduce sediment concentration in stormwater. For soils that have predominantly coarse particles (more than 67% of particles greater than 0.02 mm) the basin can be designed on the basis of sediment deposition as the flow passes through the basin. For predominantly fine soils (more than 33% of particles smaller than 0.02 mm) runoff needs to be captured and retained for several days to allow sedimentation to occur before the water is released.

Application

- End of pipe treatment;
- Receiving runoff that contains sediment.

Advantages

- Requires no pre-treatment, although removal of coarse debris will reduce the frequency of clean-out of the basin;
- Can be designed to remove both coarse and fine sediment;
- Provides a storage from which stormwater can be drawn for re-use on-site.

Limitations

- Large capacity required to treat runoff from areas containing a high proportion of clays, and may require dosing with a flocculant if dispersive soils are present;
- Are not effective at removing nitrogen from runoff;
- Have greater land requirements than 'at source' controls.

Guidelines for Designing Sedimentation Basins

- A sedimentation basin is designed according to the design particle size that is required to be treated. Figure 7.4 shows the volume of sedimentation zone storage required per hectare draining to the sedimentation dam for a site containing soils with greater than 33% of particles less than 0.02 mm (silts and clays). This sizing criteria is similar to the design of a Type F basin as per the "*Managing Urban Stormwater: Soils and Construction"* (NSW Department of Housing, 1998).
- An additional volume of storage (typically 30% of the sedimentation volume) is required for sediment accumulation.
- The basin should be designed so that the length to width ratio is at least 3:1 for a single inflow point, or 2:1 where multiple inflow points with baffles are used.
- Where the site contains fine soil particles the water stored within a sedimentation basin should be drawn down within at least 5 days after a rainfall event occurring (ie through irrigation).
- Basins designed to treat coarse soils (more than 67% of particles greater than 0.02 mm), the required basin size is approximately 50% of the volume shown in Figure 7.4.
- When the sediment storage zone is full, the basin will require de-silting.
- The sedimentation basin should incorporate a spillway that can safely convey the 20 year ARI peak flow from the catchment.
- Some examples of sediment basin configuration are shown in Figures 7.5 and 7.6.

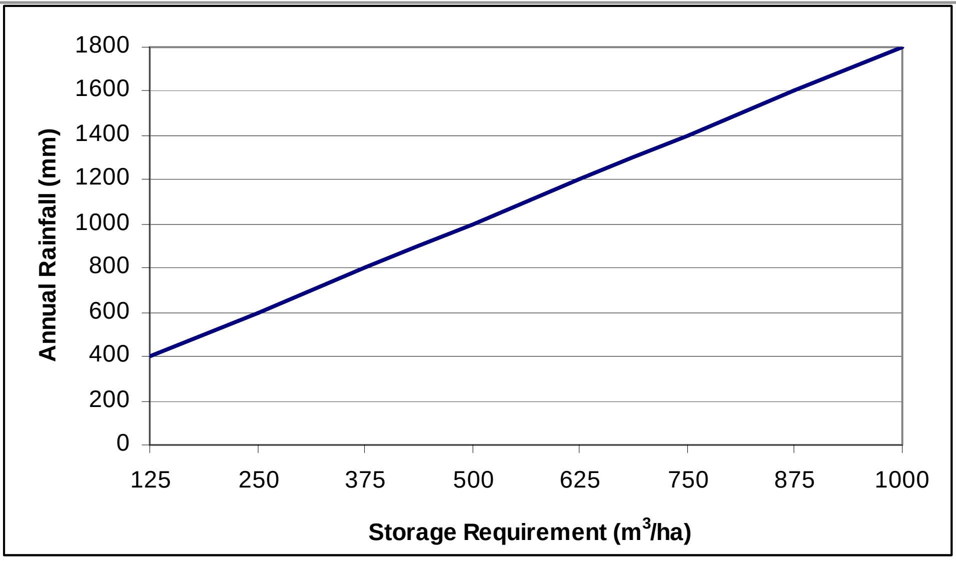


Figure 7.4
Sedimentation Basin Storage Requirement for Varying Annual Rainfall

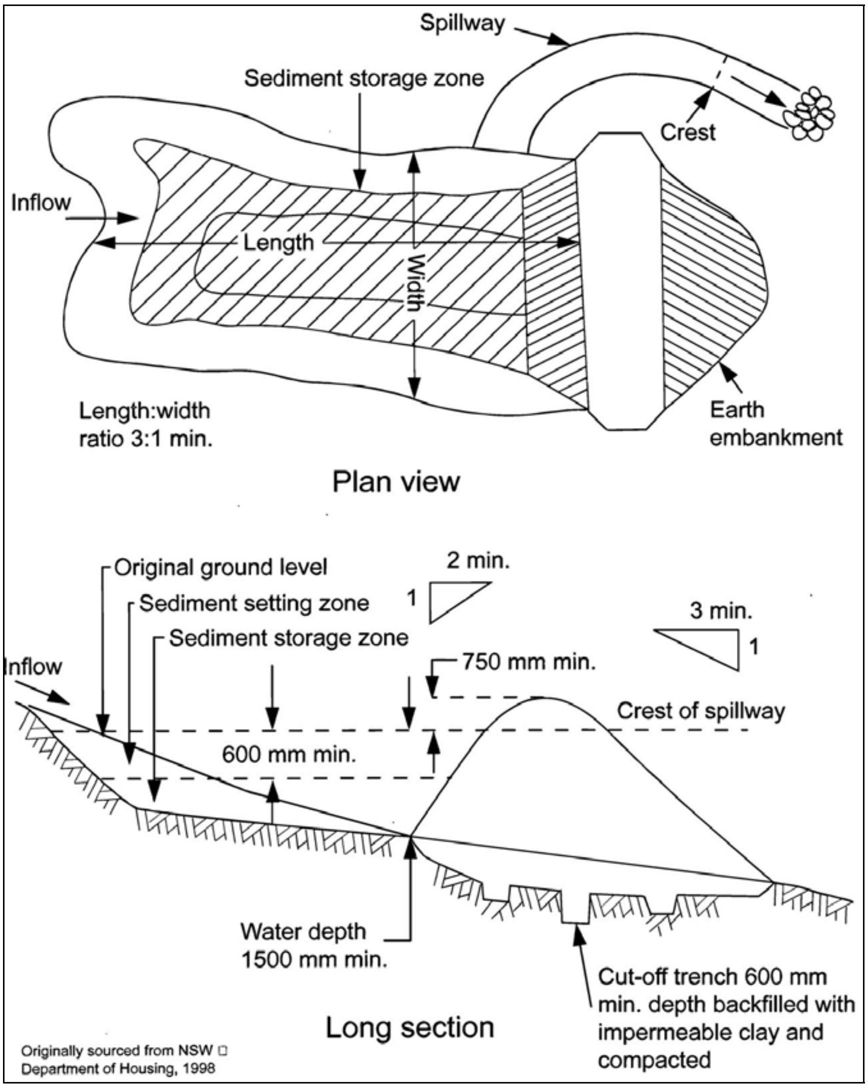


Figure 7.5
Typical Sediment Basin Arrangement for Fine Sediments

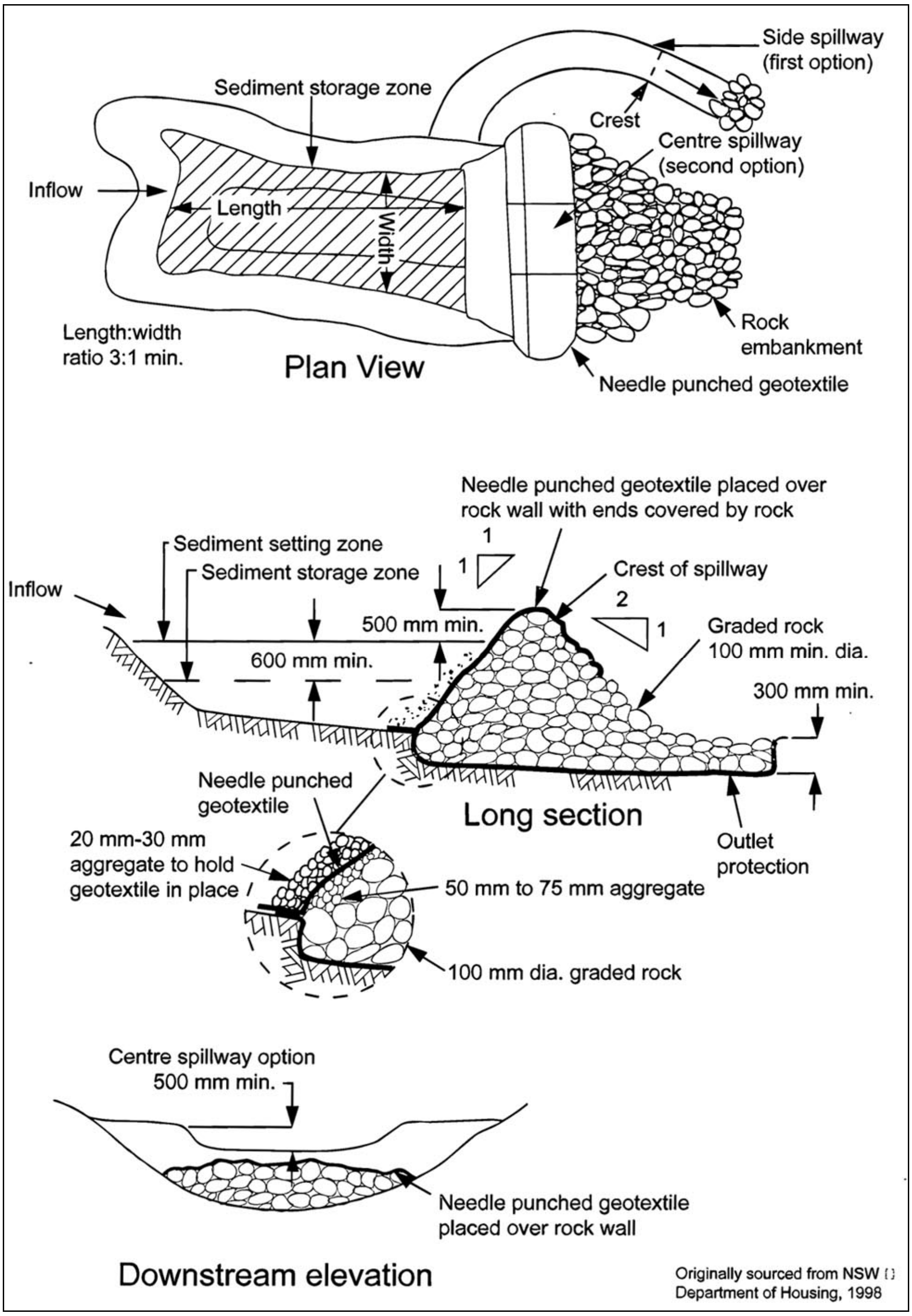


Figure 7.6
Typical Sedimentation Basin Arrangement
with Rock Filter Outlet for Coarse Sediments

7.7 CONSTRUCTED WETLANDS

Advantages

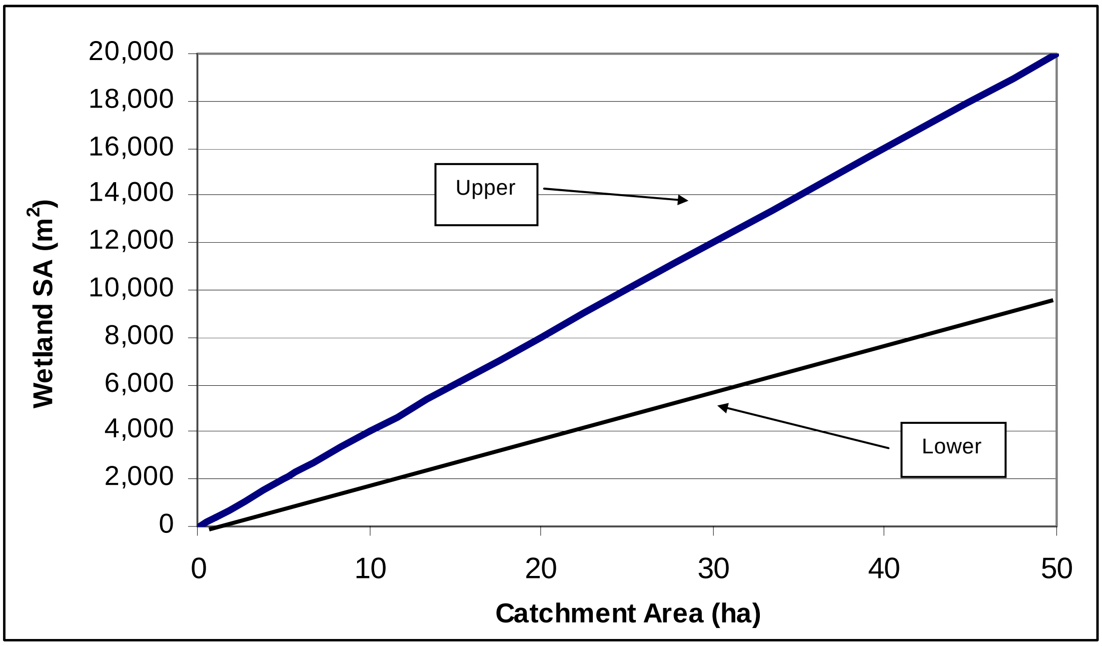
- Promotes UV disinfection of water through long hydraulic residence times.
- Can be retrofitted into existing farm dams.
- Provides good aquatic habitat.
- Wetlands have been successfully used to provide tertiary treatment for both effluent and stormwater.
- Can act as wet weather storage for effluent irrigation water, which may aid in managing excess stormwater that enters the effluent treatment system.

Limitations

- Require large land area;
- Maintenance intensive for at least the first few years after construction;
- Effectiveness in nutrient removal is governed by the overall health of the wetland.

Guidelines for Designing Constructed Wetlands

- A simple rule for sizing of a wetland is that a surface area of 2-4% of the total catchment area draining to the wetland is optimum to achieve high nutrient removal, particularly nitrogen removal. Figure 7.7 shows the surface area of wetland per hectare of contributing catchment based on a wetland surface area of 4% (upper level of treatment) and 2% (lower level of treatment) of the contributing catchment area.
- Typically a wetland with a surface area that is 2% of the catchment area would be less effective at reducing nitrogen. However, with adequate depth, a sufficiently long hydraulic residence time may be created to ensure sufficient retention of sediment and associated phosphorous.
- Wetlands with surface areas of 2% of the contributing catchment area may be very effective if the stormwater is pre-treated by another biological systems such as vegetative filter strip.
- Wetlands should be located ‘off-line’ to the drainage line to allow large flows to bypass without damaging the wetland (see Figure 7.8).
- Length to width ratio should be at least 3:1.
- Typical configuration would include the features shown in Figure 7.8:
  - open water sedimentation zone (at least 1.5 m deep);
  - shallow water macrophyte area (typically 0.3 – 0.5 m deep);
  - open water outlet zone (at least 1.5 m deep).
- Depths of up to 2 m may be used for open water areas to encourage longer hydraulic residence times and increased sedimentation, although most of the surface area should consist of shallow macrophyte zones.
- The wetland should be allowed to periodically dry out which will encourage nutrient removal and biomass decomposition on the wetland surface.

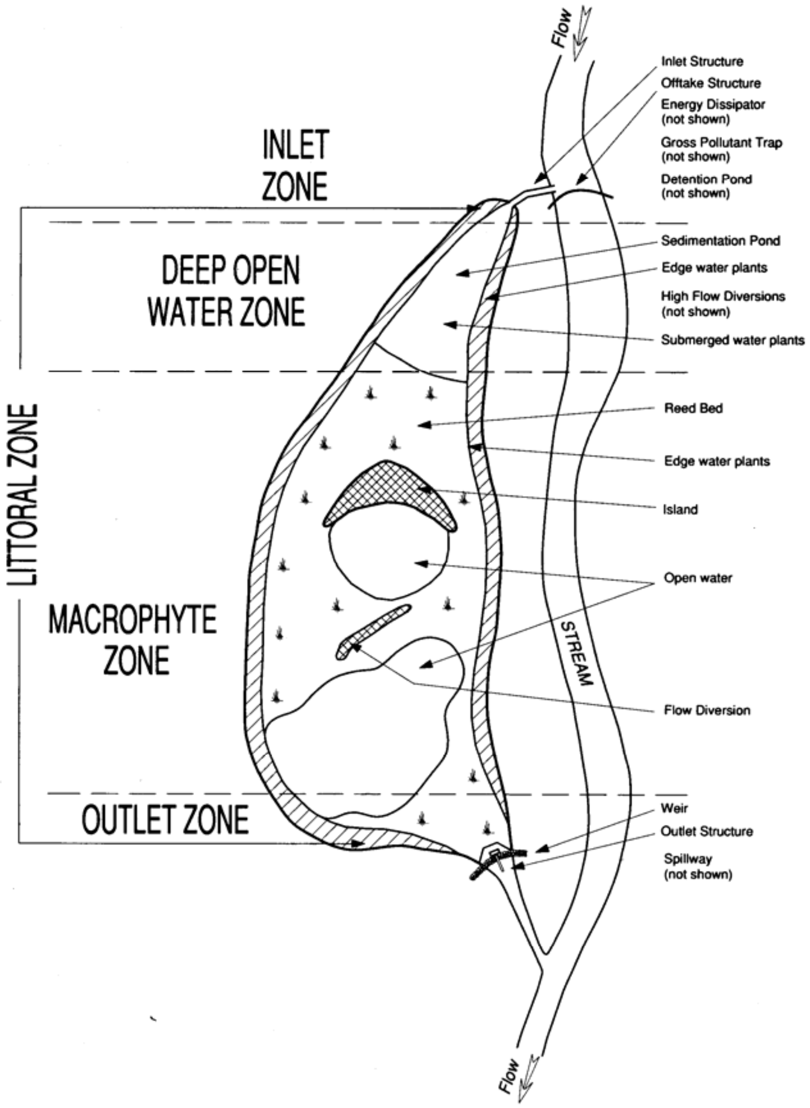


SA = Surface Area

Figure 7.7
Wetland Surface Area Requirements

It should be noted that wetlands using floating macrophytes such as duckweed are capable of much greater hydraulic loading rates, thereby reducing wetland surface area requirements. Duckweed is capable of removing 6.1 kg/ha/y of TN and 0.8 kg/ha/y of TP, which is approximately three times greater than that of emergent macrophytes (Zirschky & Reed, 1988). As a result, Duckweed systems are appropriate for applications requiring moderate hydraulic loading rates.

Small Linear Emergent Macrophyte Wetland



(Source: NSW DLWC, 1998)

Figure 7.8
Typical Arrangement of Off-stream Stormwater Wetland

7.8 EVAPORATION PONDS

Advantages/Opportunities

- Reduces brine to solid salt through evaporation.
- Reduced disposal cost of solid compared to brine due to volume reduction.
- Areas with dry, hot climates are more suitable for the use of evaporation ponds.
- Waste process heat can be used to heat the basin to accelerate evaporation.

Limitations

- Areas with wet, cool climates may not be able to utilise outdoor evaporation ponds and may require heating to achieve sufficient evaporation.

Guidelines for Designing Evaporation Basins

- Basins may be covered or uncovered. Where covering is provided, the structure needs to be open sided to allow wind to blow through. Any covering should be of a clear material that allows sunlight and infra red radiation through. Covered basins will obviously have a lower rate of evaporation loss but have the advantage of excluding rainfall. Exclusion of rainfall should be considered in areas with greater than 800 mm of rainfall.
- The depth of the basin is typically no greater than 500 mm, and will be dependant on the brine volume to be managed.
- Access for a front-end loader must be provided for removal of the salt.
- Heating of the basin using waste heat from the abattoir will enhance evaporation, particularly in winter.

7.9 BIO-RETENTION SWALES AND BASINS

A bio-retention system is essentially a vegetated swale or basin that is filled with a soil of moderate permeability overlying a perforated drain pipe to collect the percolating water. Runoff from more frequent storms (typically up to three months average recurrence interval) is retained in the swale or basin and then slowly infiltrates. The infiltration medium in the base of the swale or basin is selected so that surface water takes 24-48 hours to drain after a storm. In addition to detaining runoff so that infiltration can occur, the critical elements of a bio-retention system are:

- Permeability of the soil to allow infiltration to occur;
- Sub-surface drainage (eg perforated pipe) to collect infiltrated runoff;
- Actively growing vegetation to assist in nutrient uptake.

Advantages

- Able to remove attached and dissolved nutrients in stormwater.
- Can replace piped stormwater systems or be retrofitted into existing grass swales.
- Ability to treat low flows while conveying larger flows within the swale component.

Limitations

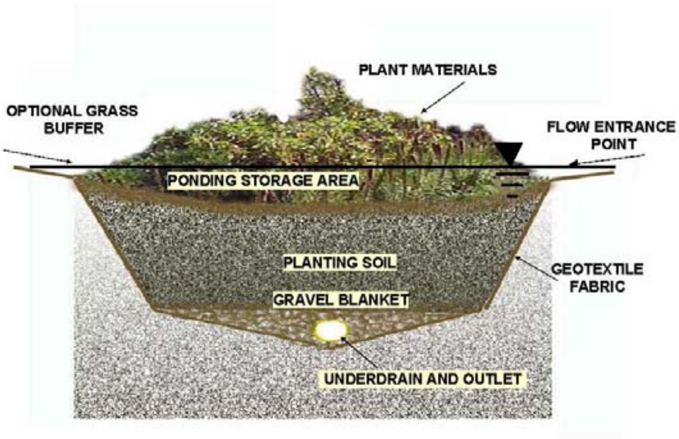
- Not suitable for areas with high groundwater tables.
- Needs to be fully vegetated to prevent clogging of soil media, otherwise a vegetative filter strip is required to remove sediment before stormwater enters the swale.
- More surface area required than a constructed wetland for the equivalent performance.

Guidelines for Designing Bio-retention Systems

- The bio-retention system should be designed to capture and retain runoff from storms up to the three month average recurrence interval storm (low flows).
- Flows larger than the design storm should be allowed to be conveyed along the swale or overflow into a piped drainage system.
- For a bio-retention basin, excess flow is discharged via an overflow pipe or weir.
- The filtration media should have permeability that is an order of magnitude larger than that of the site soil to minimise leakage of stormwater from the bio-retention system.
- The permeability of the media used will determine how well it removes dissolved nutrients, with sandy loam to sandy clay soils exhibiting the best nutrient removal characteristics.
- The surface of the swale or basin needs to be vegetated with grasses and rushes to ensure that the surface soil does not become clogged. Plants with fibrous roots rather than tap roots are most suitable for bio-retention systems.
- The infiltration area and permeability of the filtration media should be selected to allow the retained water to drain within 24-48 hours (see Table 7.1 for typical values of permeability for different soils)

Table 7.1
Typical Permeability of Different Soil Types

Soil Type	Typical Particle Size (mm)	Permeability (m/day)
Gravel	2	850
Coarse Sand	1	85
Sand	0.7	8.5
Sandy Loam	0.45	4.5
Sandy Clay	0.01	1.0



7.10 COMMERCIALLY AVAILABLE TREATMENT DEVICES

A range of commercially stormwater treatment devices is available to remove litter, coarse sediment and, in some instances, oils. New devices are coming on to the market continually and, although they are primarily targeted towards urban stormwater pollution control, they could be utilised within the operational areas of abattoirs. There are three basic classes of treatment devices, (some commercial systems include more that one of the basic processes in a single device):

- **Gross pollutant traps** that use a net or perforated metal screen to provide primary level treatment in order to retain gross pollutants such as litter and coarse vegetative matter. These devices range from simple net type systems (located in a collection pit or attached to the end of a pipe), to sophisticated systems with non-clogging characteristics achieved by tangential flow across the face of the screen. The filtration of water through the accumulated gross pollutants retains some coarse sediments that are finer than the aperture size of the mesh or screen.
- **Sediment and oil traps** that rely on creating flow conditions in a tank in which sediment is deposited in the bottom of a tank and oils are trapped above the tank outlet. The simplest form of this type of device is a simple 'triple interceptor pit' similar to that shown in Figure 7.3 in which water is directed over and under a series of weirs in a tank. The more sophisticated devices have complex internal configurations designed to create hydraulic conditions that enhance the deposition of sediment and retention of oil.
- **Advanced filtration systems** that rely on filtration of the stormwater through a selected granular filter medium. Because these systems rely on filtration through a granular medium, the treatable flow rate is quite small and detention storage is necessary to retain a volume of stormwater for subsequent treatment after the peak of the storm. By selecting the filter medium, these devices can be designed to target particular pollutants (eg use of activated carbon to retain hydrocarbons). Because of their sophistication and cost, these devices are only likely to be warranted where there is need for a very high standard of treatment.

Advantages

- Capable of operating a very high hydraulic loading rates.
- Treatable flow rates typically between 0.02 m^3/s and 4 m^3/s depending on the size of device.
- Easily retro-fitted into an existing piped stormwater system.
- Maintenance costs reduce as more of the same type of device are used on a site.

Limitations

- Considerable capital costs compared to vegetative filter strips and simple solids traps, although cheaper than constructed wetlands.
- Only capable of removing litter, sediment and oils not dissolved pollutants.
- Maintenance costs are moderate, many devices require a vacuum truck for pollutant removal approximately every 3 - 6 months.

8.0 STORMWATER MANAGEMENT PLANS

A stormwater management plan (SMP) is often required as part of the overall environmental management for abattoirs, particularly when they are located near ecological significant areas or major waterways An SMP is usually produced to satisfy the requirements of an environmental protection licence. Notwithstanding any regulatory requirement, a stormwater management plan is a useful element for incorporation into an abattoir's overall environmental management plan (EMP), or as a stand alone document to identify stormwater management priorities.

In view of the increasing scrutiny of the environmental performance of abattoirs, it is recommended that all abattoirs prepare an SMP or at least address the relevant issues in the overall environmental management plan.

In essence, a Stormwater Management Plan provides an assessment where the risks to stormwater quality are identified, ranked and suitable mitigation options presented. **The primary objective of a Stormwater Management Plan is:**

- **To identify sources of stormwater degradation and actions by which the environmental values of receiving waters will be protected.**

Specific matters that should be addressed in a stormwater management plan include:

- Identification of all potential sources of stormwater on the site and classification of the stormwater sub-catchments into clean, dirty and contaminated areas;
- Identification of the likely sources of stormwater contamination and types of pollutants generated from different areas;
- Preparation of a plan indicating all stormwater management facilities, existing natural drainage lines, areas where stormwater may be degraded and the stormwater discharge points;
- Identification of where all pits and pipes discharge to, in order to ensure that cross connections between the effluent treatment and stormwater system do not occur;
- Identification of any ecologically significant areas in the surrounding environment that could be affected by stormwater discharges offsite;
- Specification of any operational measures to minimise the volume of stormwater generated;
- Specification of any stormwater re-use practices;
- Specification of separation strategies for minimising the volume of 'dirty' and 'contaminated' stormwater;
- Specification of how stormwater will be treated, to what quality, and where/how it will be disposed of;
- Identification of potential impacts of stormwater handling, treatment and disposal methods on surface water and groundwater and how these impacts will be prevented or minimised. Both quality (eg. concentration of pollutants) and volume (eg. flooding potential) impacts need to be addressed;
- Justification of the design methodology for stormwater treatment devices (eg. criteria for sediment basin sizing);
- Preparation of a list of prioritised actions.

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APPENDIX A

REVIEW OF LEGISLATION PERTAINING TO STORMWATER MANAGEMENT AT ABATTOIRS

The following sections summarise the state of legislation, regulations and guidelines relating to stormwater management across Australia, with emphasis on stormwater management for the meat processing industry.

A-1.1 AUSTRALIAN CAPITAL TERRITORY

Under sections 24 and 30 of the "*Environment Protection Act 1997 (ACT)",* the ACT Environmental Management Authority may generate environmental protection policies. The stormwater control policy ("*Water Pollution Environment Protection Policy", 1999)* specifically mentions stormwater control on abattoirs, where the main sources of pollution identified include:

- water from animal processing operations;
- stormwater runoff from holding paddocks; and
- effluent from skin preservation and drying sheds.

The "*Water Pollution Environment Protection Policy"* prescribes diversion of clean stormwater away from intensive use areas, capture and treatment of contaminated stormwater. Irrigation is considered an appropriate form of disposal for contaminated stormwater. The Policy requires that abattoir managers should:

- dispose of all wastewater from animal processing operations to sewer but only with Australian Capital Territory Energy and Water's (ACTEW's) approval;
- divert skin preservation effluent to an evaporation pond for conversion to a solid waste for either recycling or appropriate disposal;
- control stormwater runoff from holding paddocks to minimise discharge to waterways (these may include vegetative buffer areas adjacent to creeks and other drainage lines);
- exclude stock from buffer areas and drainage lines;
- collect contaminated stormwater runoff in lagoons and either treat or aerate and irrigate; and
- divert clean stormwater runoff away from intensively used holding paddocks.

Most of the requirements imposed on abattoirs are related to the granting of an environmental licence.

A-1.2 NEW SOUTH WALES

In New South Wales, environmental protection licences may be issued to abattoirs. A licence may regulate the environmental impact of the activity, including noise, air, waste and water discharges. Although a number of industries are subject to load based licensing under the "*Protection of the Environment Operations Act"* (1997), meat processing industries are not subject to this provision.

The NSW Environment Protection Authority has also produced "*Abattoir Industry Guidelines".* This document describes the environmental problems associated with abattoirs. It recommends management strategies for minimising water, air and noise pollution and for maintaining community amenity. The "*Abattoir Industry Guidelines"* identify the following techniques for the management of stormwater:

- Diversion away from intensively used holding areas, bulk chemical storage and liquid waste collection areas and treatment and disposal areas. This can be done by roofing or isolating unloading areas, stockyards and processing plant, as well as by building diversion drains and bunding.

- Collection of contaminated stormwater in lagoons, followed by aeration and irrigation without any off-site runoff.
- Ensuring that clean stormwater is kept away from contaminated areas and directed to the stormwater drainage system. It may be collected for stock watering or washing down.

The NSW EPA in association with other agencies have also produced a series of "*Managing Urban Stormwater"* documents (some of which are still in draft form) to assist councils, State Government agencies, developers and consultants to improve stormwater management practices. The draft "*Managing Urban Stormwater: Council Handbook*" (EPA, 1998) provides guidance to councils and other stormwater managers on preparing stormwater management plans. These guidelines are, however, mainly concerned with stormwater management plans for urban stormwater.

The Draft NSW EPA guidelines "*Use of Effluent for Irrigation"* (1995) provides details of requirements for the use irrigation as an effluent disposal method by abattoirs and other industries. In relation to stormwater, the guidelines require that the quality of waterways in a catchment must not be degraded by runoff from an effluent irrigation area. The guidelines recommend that this be achieved by providing an adequate buffer zone between the irrigation area and any watercourse and by practicing well managed irrigation in order to reduce any surface runoff.

A-1.3 NORTHERN TERRITORY

The Department of Infrastructure, Planning and Environment treats the assessment, design and control of each stormwater management system on a case by case basis. Some basic stormwater management principles are suggested with the Department generally recommending that all businesses and industries:

- ensure the correct storage and disposal of wastes;
- protect storage tanks with a runoff control barrier capable of containing a spill resulting from a tank rupture;
- regularly inspect and maintain equipment to avoid accidental leaks, spills etc.;
- re-think wash down and clean up procedures;
- try to keep stormwater away from potential pollutant sources by covering them or installing drainage works to divert stormwater away from them;
- use 'grass and block' techniques for car parks and paved surfaces to reduce the amount of runoff;
- implement an environmental incident reporting system which requires all staff to report and record all incidents and ensure that correct procedures are followed in the event of spills, discharges or complaints;
- ensure that there are no illegal connections from stormwater drains or the sewer.

A-1.4 QUEENSLAND

In deciding whether to grant or refuse an application for an environmental license, the Queensland Environmental Protection Authority (EPA) considers:

- the existing quality of water that may be affected by the release of contaminated stormwater to a roadside gutter, stormwater drain or surface water;
- the cumulative effect of the release in question and any other releases of contaminants to the water known to the EPA; and
- the topography of the locality and local climatic conditions.

If the EPA determines that the management of stormwater releases from the activity is not likely to be adequate to prevent or minimise environmental harm, the EPA may require the licence applicant:

- to implement waste prevention measures, including, for example:
  - diverting upstream stormwater runoff away from contaminated areas;
  - minimising the size of contaminated areas;
  - covering, paving or roofing contaminated areas; and
  - cleaning contaminated areas without using water;
- to install control or treatment measures including, for example, artificial wetlands, buffers that improve waste water quality, bunding, first flush stormwater diversion systems, oil separators and silt and rubbish traps; or
- if the activity involves exposing or disturbing soil;
  - to implement waste prevention measures, including, for example, minimising the amount of soil being exposed or disturbed by staging works associated with the activity and revegetating or mulching exposed or disturbed areas as quickly as possible; or
  - to install control or treatment measures including, for example, buffers that improve waste water quality, silt fences and settling basins.

The Queensland EPA and Queensland Parks and Wildlife Service have also produced an information sheet entitled "*Meat Processing, Including Rendering*" – which provides guidance on assessing the environmental impacts associated with abattoir sites. The information sheet identifies that a licence application should include a *Site Based Management Plan (SBMP)*. This plan should identify all sources of environmental harm including, but not limited to, the actual and potential release of all contaminants, the potential impact of these sources and what actions will be taken to prevent the likelihood of environmental harm being caused. At a minimum, the plan must address the key elements of, and assign responsibility for, any actions for the protection of stormwater. The information sheet identifies the following environmental issues that are considered to be most relevant to meat processing, and which are to be addressed in the SBMP:

- details of delineation of contaminated areas and uncontaminated areas and diversion of uncontaminated runoff (eg. from roofed areas);
- details of collection and treatment of runoff from all contaminated areas (eg. livestock pens, solid waste holding areas) and treatment/re-use/disposal of contaminated runoff; and
- details of stormwater management practices, including containment of liquid fuels, chemicals and products (eg. tallow and housekeeping measures).

A-1.5 SOUTH AUSTRALIA

The South Australian EPA uses *Codes of Practice* to achieve improvements in stormwater quality. Guidelines on how to prevent pollution from leaving sites by use of long term planning modification of practices and treatment at the source are provided. The EPA currently has three codes in force. Whilst none of these are specific to the meat processing industry, they do provide the following relevant guiding principles:

- eliminate non-stormwater discharges;
- control stormwater pollution at its source;
- treat stormwater runoff as a resource; and
- reduce stormwater pollution to the maximum extent.

The EPA has developed a *"Draft Environment Protection (Water Quality) Policy".* This *Policy* identifies that South Australia's abattoirs are generally large scale operations, which are licensed under the "*Environment Protection Act" (1993)* and are required to have wastewater management systems as a condition of licence.

A-1.6 TASMANIA

The "*Environmental Code of Practice for Meat Premises (Slaughtering)" (1995)* provides that the preferred method for the disposal and treatment of contaminated stormwater is via discharge into the municipal sewer system. The state government also provides general guidance on 'best practice' stormwater management. Most of the recommendations relate to urban stormwater management and no specific details are given for the meat processing industry.

A-1.7 VICTORIA

The "*State Environment Protection Policy (SEPP) (Waters of Victoria)" (2002)* identifies that the concentration of animals can also concentrate the runoff of pollutants. The SEPP repeats the provisions of the 1988 SEPP and stipulates that wastes and wastewater from intensive agricultural industries must not be discharged into surface waters. The dairy and horticultural industries have been identified as key focus areas, given their potential to impact on surface waters. Guidelines and codes of conduct referred to by the SEPP do not specifically relate to abattoirs, only intensive livestock industries such as feedlots, piggeries and dairy farms.

A-1.8 WESTERN AUSTRALIA

Western Australian law contains a substantial body of material on stormwater management applicable to abattoirs. The "*Environmental Protection (Abattoirs) Regulations" (2001)* detail specific controls for stormwater. The following clauses are particularly relevant:

- Clause 9. Storage of waste material.

  An operator must ensure that dung and manure storage areas are made of an impervious material and have bunds made of an impervious material, which are of sufficient height to contain the leachate.

- Clause 10. Uncontaminated storm water not to enter wastewater treatment system.

  An operator must ensure that storm water on the abattoir which is not contaminated with solids, grease, oils or other materials from the process of slaughtering animals does not enter the waste water treatment system.

- Clause 11. Treatment of contaminated water from lairage pens.

  An operator must ensure that water from the lairage pens of the abattoir is screened or otherwise treated to remove solids in the water before the water is discharged into the wastewater treatment system.

The "*Environmental Code of Practice for Cattle Feedlots"* produced by the Western Australian EPA provides more specific guidance on the management of stormwater in connection with livestock activities. This code of practice recommends that:

- all contaminated flows of less than one in 10 year storm events should be retained in ponds for evaporation &/or irrigation on site.
- bunds, culverts or drains should be built to divert all uncontaminated stormwater from other waste streams and processing areas in general.
- where polluted stormwater runoff cannot be prevented, a settling pit should be constructed to collect all polluted waters from areas outside the primary operation. It is further suggested that, after settling the pollutants from this water, the water be re-used via discharge to an irrigation area.

Although this code of practice relates specifically to cattle feedlots, these recommendations are applicable for management of stormwater from holding yards at abattoirs.

The WA EPA has also produced a draft guide entitled "*Guidance for the Assessment of Environmental Factors: Management of Surface Water Runoff from Industrial and Commercial Sites*" which is also applicable to abattoirs. The draft guide requires the following steps be undertaken in preparing a stormwater management plan:

- identify potential sources of stormwater on the site, including water flowing onto the site from other sources;
- specify measures to minimise the generation of stormwater (eg. diversion drains, bunding);
- identify likely contamination sources of stormwater (eg. vehicle parking areas, fuel storage, processing areas) and specify measures for minimising contamination of stormwater (eg. via a spill management plan);
- consider and specify measures for separating 'clean' stormwater (eg. from roofs) from water potentially contaminated by site activities (eg. stormwater from process areas, materials storage) to minimise the volume of water requiring treatment and disposal;
- specify how stormwater will be treated and to what quality, and where/how it will be disposed of (this will include consideration of likely volumes to be treated and disposed of); and

- identify potential impacts of stormwater handling, treatment and disposal methods on surface water and groundwater and how these impacts will be prevented or minimised. Both quality (eg. potential pollutants) and volume (eg. flooding potential) impacts need to be addressed.